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VIABILITY OF THE MOTOR VEHICLE DIAGNOSTIC INSPECTION CONCEPT DEMONSTRATED BY NHTSA*

by

Joseph J. Innes

National Highway Traffic Safety Administration

ABSTRACT

The motor vehicle diagnostic inspection program mandated by Title III of the Motor Vehicle Information and Cost Savings Act required the Secretary of Transportation to make grants and provide technical assistance to the states in order to conduct demonstration projects. The demonstrations were unprecedented in scope and in interagency cooperation. At the federal level, the program involved NHTSA, EPA, and FTC. In addition, state and city governments, universities, and private industry, as well as some 66,000 vehicle owners, participated in this effort. Starting early in 1975, the diagnostic centers conducted over 125,000 inspections by the mandated deadline of June 30, 1976. Although three of the original projects are continuing to gather data and information under the extension provisions of the Motor Vehicle Information and Cost Savings Act Amendments of 1976, there is much evidence today to show that the diagnostic concept is practical and offers great promise to consumers and repair industry alike. Diagnostic motor vehicle inspection will benefit consumers by providing them information and data on the condition of vehicles, which, if used properly, can result in greater safety, lower pollution, improved gas mileage, and generally lower overall repair and maintenance costs.

INTRODUCTION

The National Highway Traffic Safety Administration (NHTSA), U.S. Department of Transportation, recently completed phase one of a multimillion dollar motor vehicle diagnostic inspection (MVDI) demon-

stration program. The goal of the federally funded demonstration was to determine if a national system of diagnostic inspection centers would be cost-effective in the sense that the public benefits would exceed the program costs. The specific objectives of the program were to provide information and data on the following subjects:

1. The relative costs and benefits of the project.
2. The capability of the motor vehicle repair industry to correct diagnosed deficiencies or malfunctions and the cost of such repairs.
3. Vehicle-in-use standards and feasible reject levels.
4. The efficiency of facility designs employed.
5. The degree of standardization of diagnostic systems and test equipment.
6. The development of diagnostic equipment designed to maximize the interchangeability and interface capability.
7. Vehicle designs which facilitate or hinder inspection and repair.

To meet these objectives, NHTSA established a comprehensive program for the acquisition, processing, and analysis of information and data. At the federal level, NHTSA provided the basic support. It established test criteria and diagnostic inspection procedures, designed the experiment, and provided the overall technical management to assure timely and successful implementation of the projects. To satisfy the provisions of the Motor Vehicle Information and Cost Savings Act, five such demonstration sites were selected competitively; and, through cooperative agreements, federal funds were awarded to the states in the form of grants with matching state contributions. The five projects selected for the demonstration were lo-

* Prepared for presentation at the Fifth International Congress on Automotive Safety, Cambridge, Massachusetts, July 11-14, 1977.

cated in Alabama, Arizona, Tennessee, the District of Columbia, and Puerto Rico. Under the technical supervision of NHTSA's staff, the D.C. motor vehicle diagnostic inspection pilot lane was dedicated to the demonstration, and six new facilities were constructed and equipped with modern diagnostic equipment to conduct safety and emission inspections. While much of the diagnostic equipment employed in this demonstration was of necessity off-the-shelf, some modifications were encouraged to improve system performance.

Two contractors were engaged to provide essential support activities. An engineering support contractor monitored the quality control and reported on project operations and equipment calibration through periodic on-site audits. The focal point for collecting, process-

ing, and analyzing data was provided by a program evaluation support contractor. This source was responsible for the ADP activities including periodic data evaluation reports as prescribed by NHTSA to aid overall project management. Although these early data returns could not be used to reach definite conclusions concerning diagnostic inspection, the data were useful in identifying and explaining certain trends with regard to vehicle failure rates, outages by system, subsystem, and components, as well as the vehicle recruiting efforts. Thus, these early trends facilitated corrective measures in vehicle recruiting activities by identifying hard-to-fill cells and aided in the assessment of the pass/fail criteria and repair cost information to assure statistical validity of data.

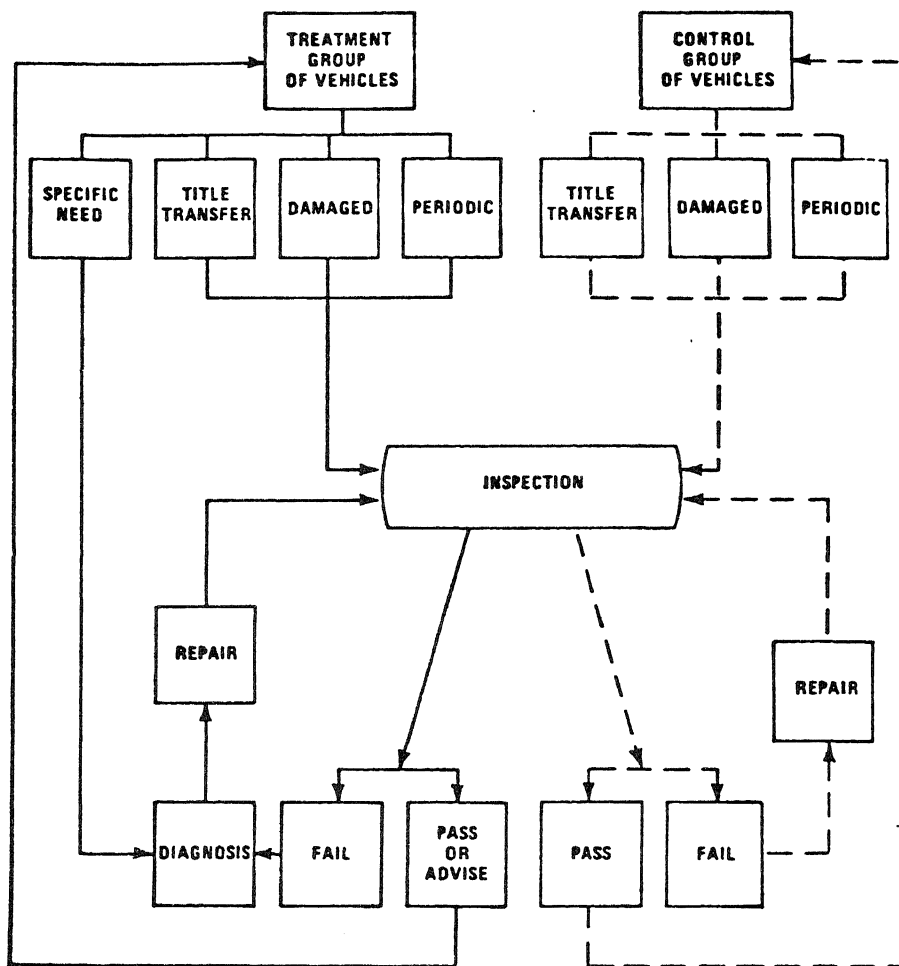


FIGURE 1.—Vehicle Inspection and Repair Cycle Flow Chart

MOTOR VEHICLE DIAGNOSTIC INSPECTION CONCEPT

Inspection/Maintenance Cycle

In order to make a meaningful evaluation of the relative costs and benefits of the projects, two similar groups of 1968–1973 model year vehicles were established at each site. One group was designated the diagnostic or “treatment” group, i.e., the group of vehicles which received specific technical diagnostic information in order to facilitate correction of any component failing inspection. The second group was designated the “control” group, i.e., the group against which the costs and benefits of diagnosis were measured. This group received only pass-fail information. Both groups received a periodic safety and emission inspection in accordance with established criteria. However, only the vehicles in the treatment group received the diagnostic information. A flow chart of the inspection and repair cycle for vehicles enrolled in the demonstration is shown in Fig. 1. In addition to the normal periodic inspection, vehicles were in-

spected whenever the title was transferred to another person, unless the transfer was for the purpose of re-sale, or whenever the vehicle sustained substantial damage to any safety or emission-related system as prescribed by regulation.

Data Collection and Reporting

Inspection forms were designed to facilitate transfer of information to 80-column punch cards. Although the projects in areas with mandatory periodic motor vehicle inspection (PMVI) were permitted to use their normal inspection forms for the control group and compatible forms for the diagnostic group, NHTSA had the final word on the design to assure uniformity and to facilitate data processing and evaluation. The flow of information is shown in Fig. 2.

In addition to the pass/fail and diagnostic information, it was extremely important that repair and maintenance costs were gathered over the entire time span that a vehicle was in the program, not only for inspection-related repairs, but also for repair costs for normal maintenance between inspections. This was

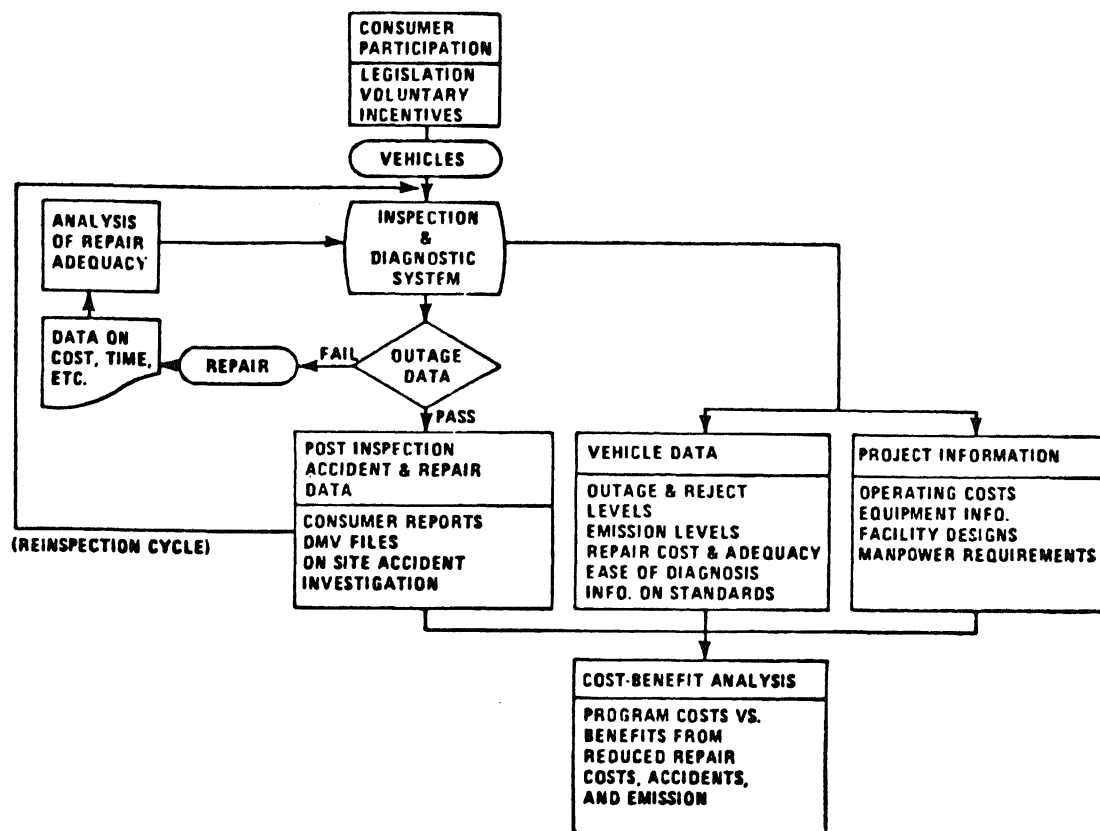


FIGURE 2.—Motor Vehicle Diagnostic Inspection Data Flow Chart

necessary for both the control and diagnostic groups so that a comparison could be made between the two to see if a reduction in overall repair costs was achieved by the diagnostic group. To the extent possible, parts and labor costs were listed separately for each operation so that inspection-related costs could be separated from owner-requested repairs not associated with the inspection.

THE COMPUTERIZED DIAGNOSTIC INSPECTION LANE

Computer System

Although participating states were provided latitude in the design of facilities and selection of diagnostic equipment, only the District of Columbia engineering pilot lane was designed and equipped with a com-

puterized AVCO 210 diagnostic inspection system (Fig. 3).

The system was designed to provide on-line, real-time computer control over all inspection sequences. The AVCO 210 was built around a Digital Equipment Corporation Minicomputer (PDP 11/05) with a 20,000-word memory and a disc system (DEC RK05) with unformatted capacity of 24.4 million bits that interfaces the computer with a DEC RK11-DE/DJ disc controller.

In addition to directing all inspection sequences, the computer system received manually fed inspection data from visual observations and direct outputs of major pieces of test equipment and made pass-advise/reject decisions against stored tables of limits. It also compiled lane statistics and transmitted data to a master computer bank on command.

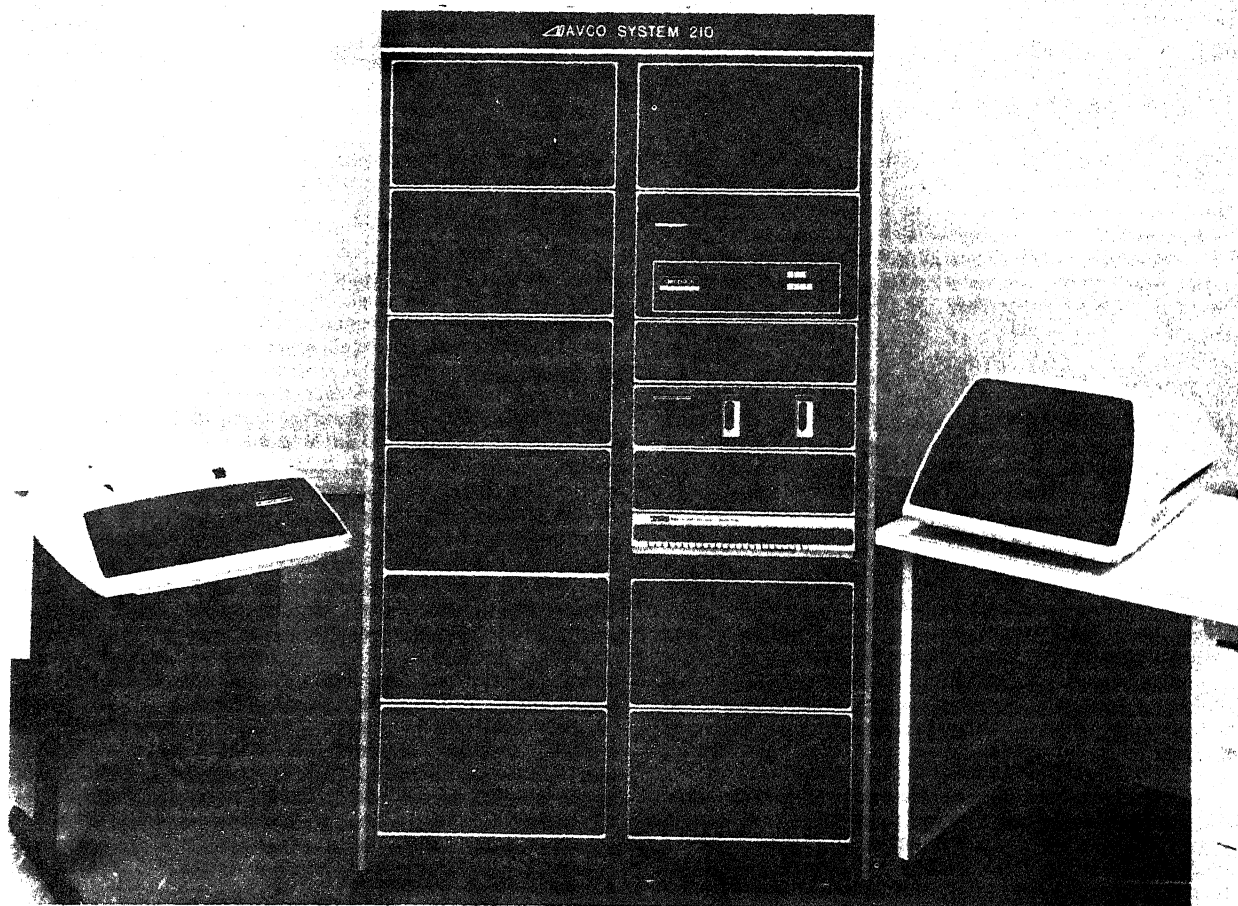


FIGURE 3.—Motor Vehicle Diagnostic Inspection Computer System

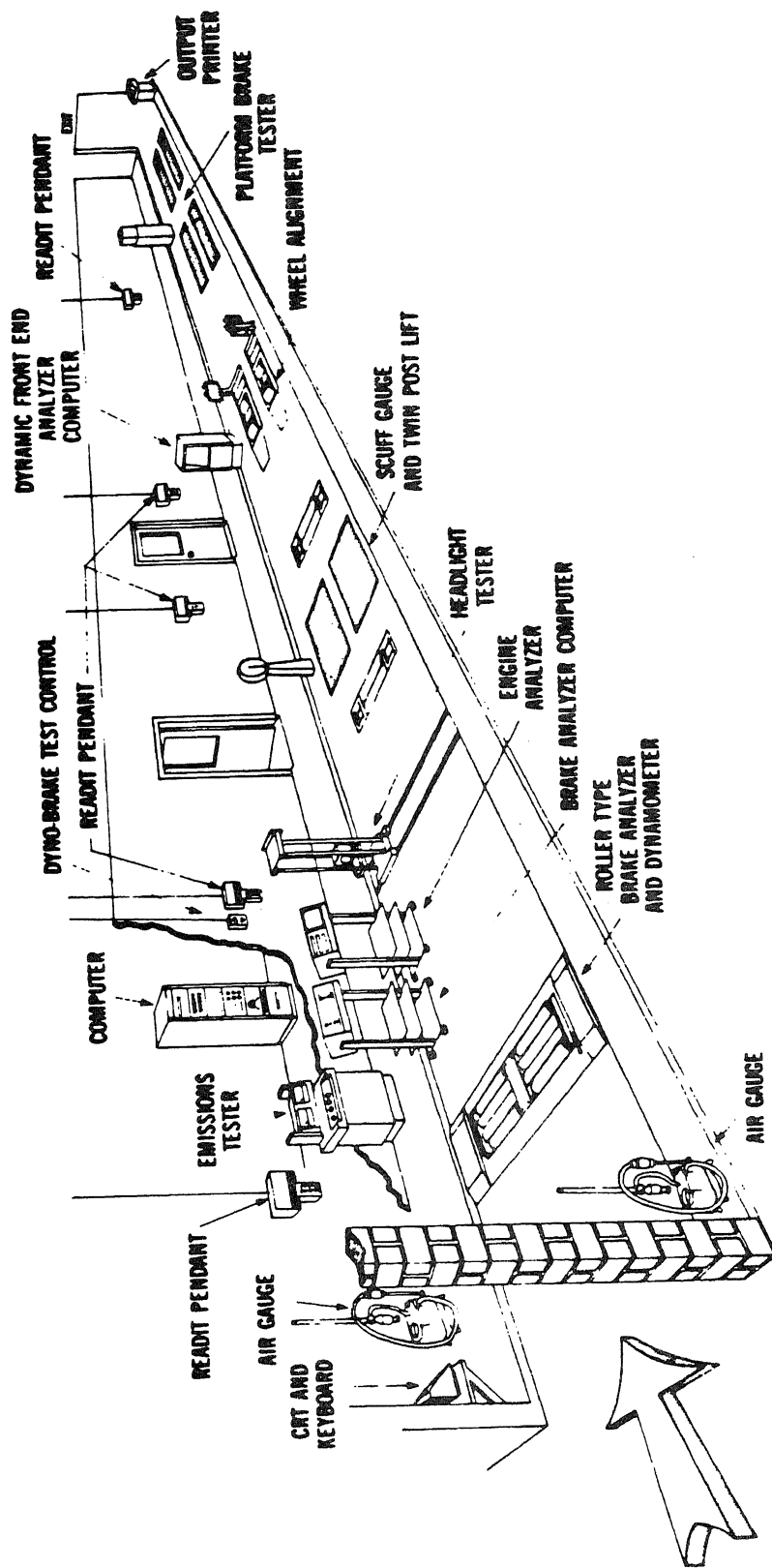


FIGURE 4.—Motor Vehicle Diagnostic Inspection Lane

A motor vehicle to be inspected is first identified to the computer system by entry of pertinent vehicle information via a cathode ray tube (CRT) keyboard terminal at the entrance to the inspection lane (Fig. 4). The system then establishes a data file for the vehicle and selects appropriate inspection standards to which vehicle data—derived automatically from test machines or manually via remote entry and display terminals (READITs)—are entered. All communication between the inspectors at each test station and the computer is carried on via the hand-held, overhead-supported READIT pendants. Five of these pendants are suspended along the lane—one each at inspection stations 1, 3, and 4 and two at inspection station 2. A close-up of a READIT pendant is shown in Fig. 5. The system file contains tables of specification limits against which front-end alignment and ball joint play measurements are compared to determine the acceptability or unacceptability of the vehicle being tested. In addition to using data from these tables, the system selects appropriate tests based upon the body style and model year of each vehicle tested.

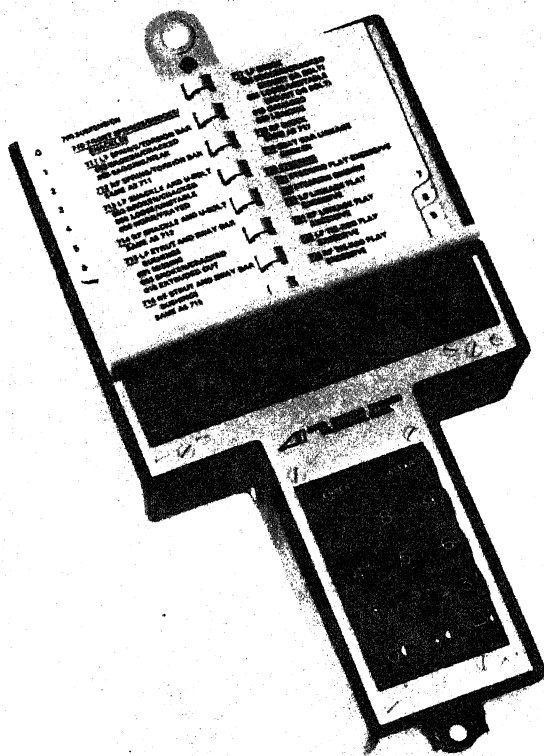


FIGURE 5.—Remote Entry and Display Inspection Terminal (READIT)

Each test station in the lane contains one or more items of motor vehicle test equipment directly connected to the computer, and each is also assigned a sequence of manual tests to be conducted in a prescribed order. The inspector need only determine that a specific test is required or unacceptable. The computer makes all advise or reject decisions on the basis of criteria entered in the system.

All direct interfaces between the computer and the test equipment involve test equipment output data only and in no way influence the normal operation of this equipment. In all instances, the test equipment is operated using the same procedures as would be used without the direct computer tie. Thus, this equipment may be operated manually at any time without regard for the status of the computer. A description of the major pieces of equipment shown in Figure 4 and the automatic interface with the computer system follow.

Entrance Station

The entrance station contains a CRT display and integral keyboard unit used for entering vehicle identification information into the system and for all communication with the computer system. The CRT also provides means for editing test sequences, viewing lane statistics, changing modes of operation, detecting and correcting anomalous operation, and for all off-line communications with the computer.

This unit is an entirely self-contained alphanumeric video display unit that can display up to 1,440 characters large and legible enough to be easily read.

Station 1

Station 1 contains READIT pendant 1, a roller brake tester, an exhaust emission tester, and a chassis dynamometer. The READIT provides a 15-character alphanumeric display for presenting computer-generated instructions to the inspector and a compact keyboard containing 14 keys (10 numeric and 4 special function) used by the inspector to enter judgments and commands to the system. A code book affixed to the front of the READIT (see Figure 5) provides a complete listing of all GENERAL, SPECIAL, and TEST ID codes for convenient reference.

Roller Brake Tester. The system interfaces directly with the output of the minicomputer-controller of the tester. All front panel MARGINAL and FAIL light indicators of that equipment are monitored directly by the AVCO System 210 computer upon com-

mand of the inspector via the READIT. The system records all MARGINAL and FAIL lamps operated during the brake test. In April 1975, this minicomputer-controller was shut down and the brake analyzer was operated manually. The chassis dynamometer described next is integral with this brake analyzer.

Chassis Dynamometer. The system interfaces directly with the chassis dynamometer, and both the ROADSPEED and HORSEPOWER analog meters of that device are monitored by the computer. Upon command of the inspector via the READIT, the system records the meter values and stores them in the Vehicle Processing File for the vehicle under test. These readings are taken simultaneously with the exhaust emission readings in response to a single inspector command.

Exhaust Emissions Tester. The system interfaces directly with the exhaust emissions analyzer, and both the hydrocarbon (HC) and carbon monoxide (CO) analog meters and their associated range switches are monitored by the computer. Upon command of the inspector via the READIT, the system records the meter values and compares them to standard values for the model year of the vehicle under test.

Station 2

Station 2 contains READIT pendants 2 and 3 and a scuff gauge. Since READITs 2 and 3 are used in the same station, they are so coupled into the system that all testing assigned to each READIT at that station must be accomplished before a vehicle can be logically cleared from this station. They operate as independent READITs in all other respects.

Scuff Gauge. The system interfaces directly with the scuff gauge, and both the scuff value and direction are monitored by the computer. Upon command of the inspector via the READIT, the system records the peak scuff value and direction of scuff and compares these values to the standard value stored in the system.

Station 3

Station 3 contains READIT pendant 4 and a dynamic front end alignment tester.

Front-End Alignment Tester. The system interfaces directly with the dynamic front-end alignment tester, and all CAMBER, CASTER, and TOE analog meter outputs are monitored by the computer. Upon command of the inspector via the READIT, the system records the meter values and compares the CASTER,

CAMBER, and TOE values to the specification values for the make, model, and year of the vehicle under test.

Station 4

Station 4 contains READIT pendant 5 and a platform brake tester.

Platform Brake Tester. The system interfaces directly with the platform brake tester, and the force levels on all four platforms are monitored by the computer. Upon command of the inspector via the READIT, the system records the peak platform force levels; computes the side-to-side imbalance ratios of both axles and the front-to-rear imbalance; and compares these imbalance values with standard values. The system also compares the imbalance values with those determined during the roller brake test (conducted earlier in the lane).

Exit Station

The exit station contains a line printer with an integral keyboard unit.

The printer generates a concise report (with a carbon copy) of inspection results at the lane exit. One copy is given to the vehicle owner and the other is retained on file at the inspection facility. The printout is made automatically on special forms pre-printed with general information. The form used by the District of Columbia, Bureau of Motor Vehicle Services, is extremely functional in relaying diagnostic information to owner and garage.

This unit prints from a set of 64 characters at speeds of up to 30 characters per second. Data is entered from a 96-character keyboard. It is also used in changing the number of sequence of the stickers used to indicate that vehicles have satisfactorily completed inspection.

SOFTWARE SYSTEM

Data Management

The principal objective of the MVDI demonstration program was the collection of data and information. The diagnostic inspection information management system consists of two subsystems: (1) diagnostic inspection data and (2) repair cost data. Consequently, there are two data bases tied together by a common key data element. Fig. 6 shows the flow of information from punched cards or magnetic tapes into the data base and from the data base into reports.

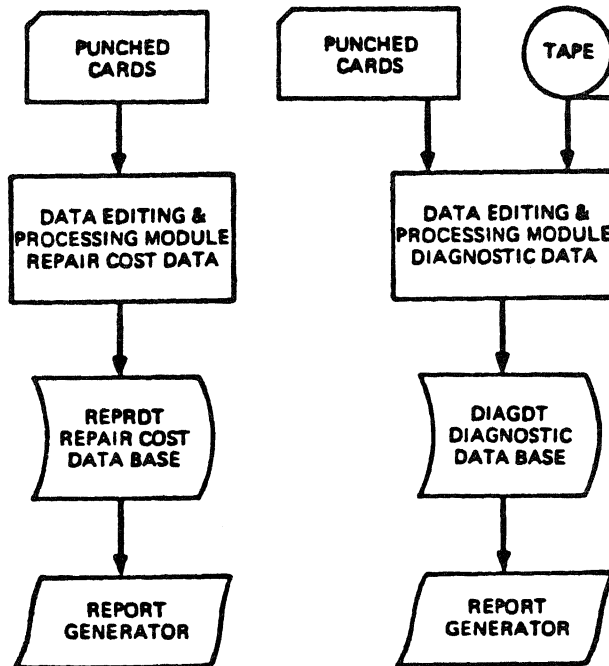


FIGURE 6.—Overview of Software Processing System

The data editing and processing module for the diagnostic data (periodic inspection results) performs the following functions:

- Data items of inspection are checked for correctness, e.g., alphanumeric item codes are checked for their correctness, diagnostic codes are checked for validity, etc.
- VIN number is decoded to determine the vehicle year and the appropriate make/model code.
- All vehicles having errors in VIN numbers are treated as unacceptables because vehicle retrieval is based on the record key that consists of:
 1. Site code
 2. Make/model code
 3. Year code
 4. VIN number

Tennessee, Alabama, Arizona, Puerto Rico, and D.C. control groups were processed by one preprocessor that includes the above functions, but D.C. treatment did not provide VIN numbers and, therefore, had to be handled in a separate preprocessor. To help determine the appropriate make/model code where VIN

is not provided, the vehicle make and model are coded in standard acronyms.

Fig. 7 presents the system flow and functions leading up to the entry of data into the diagnostic data base. It is important to note the differences in the activities performed for each state. These differences result from the manner and format in which the states collect and submit data to the program evaluation contractor, Computer Science Corporation (CSC).

Another significant point is that CSC designed and implemented a VIN decode routine that was utilized to determine the vehicle model. This procedure ensured the accuracy of the data and reduced manual edit and keypunching time.

Unlike diagnostic data, the repair cost data processing was uniform for all state sites. The repair bills were forwarded to CSC along with the reinspection forms, and the repair bills were edited and analyzed by CSC. The repair cost was allocated to the item level for each subsystem. This information was coded, keypunched, and then processed by this module. The functions of this module are similar to those described for the diagnostic data module. Fig. 8 presents the system flow for the repair cost data base.

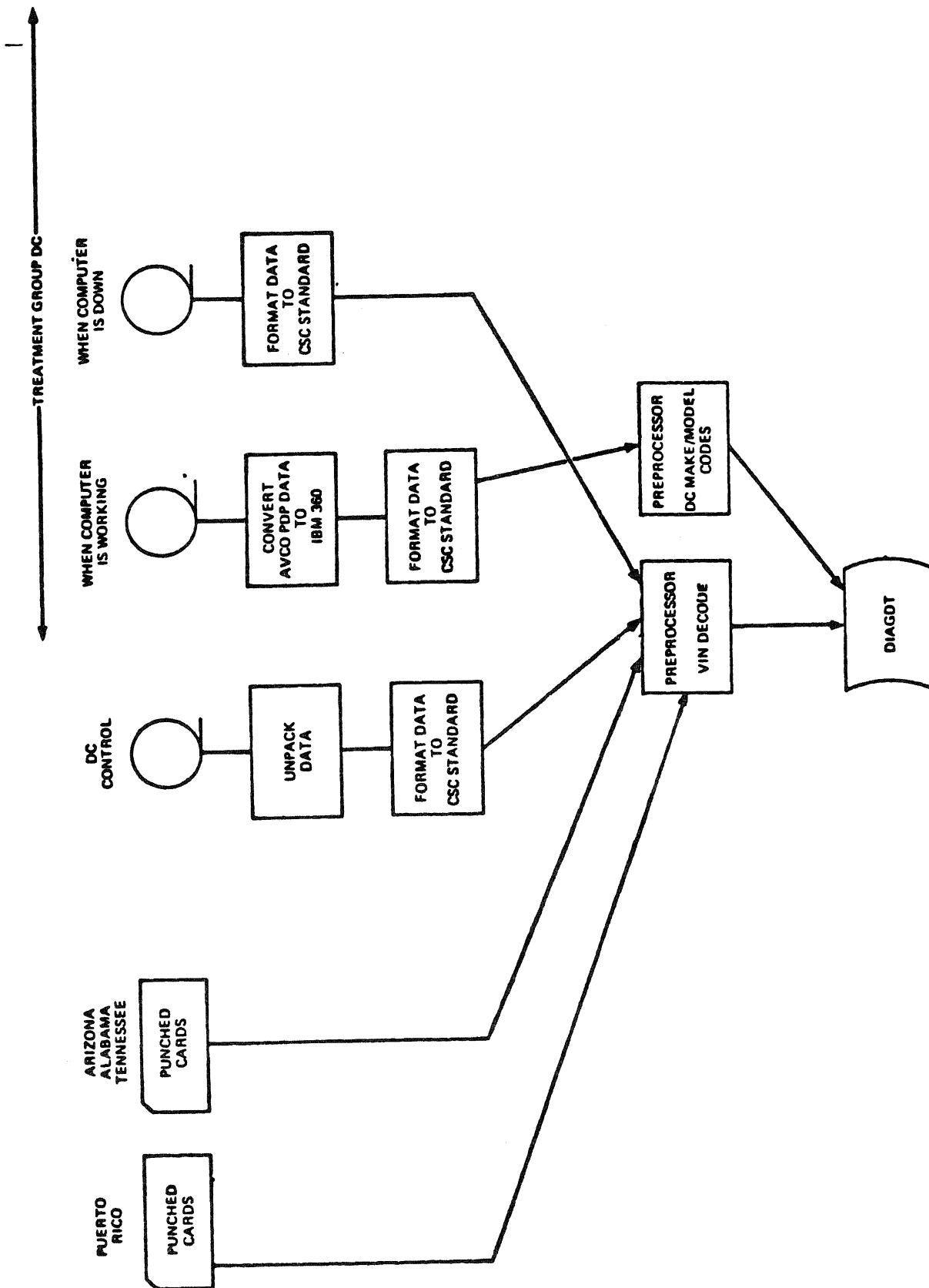


FIGURE 7.—Data Editing and Processing Module for All States

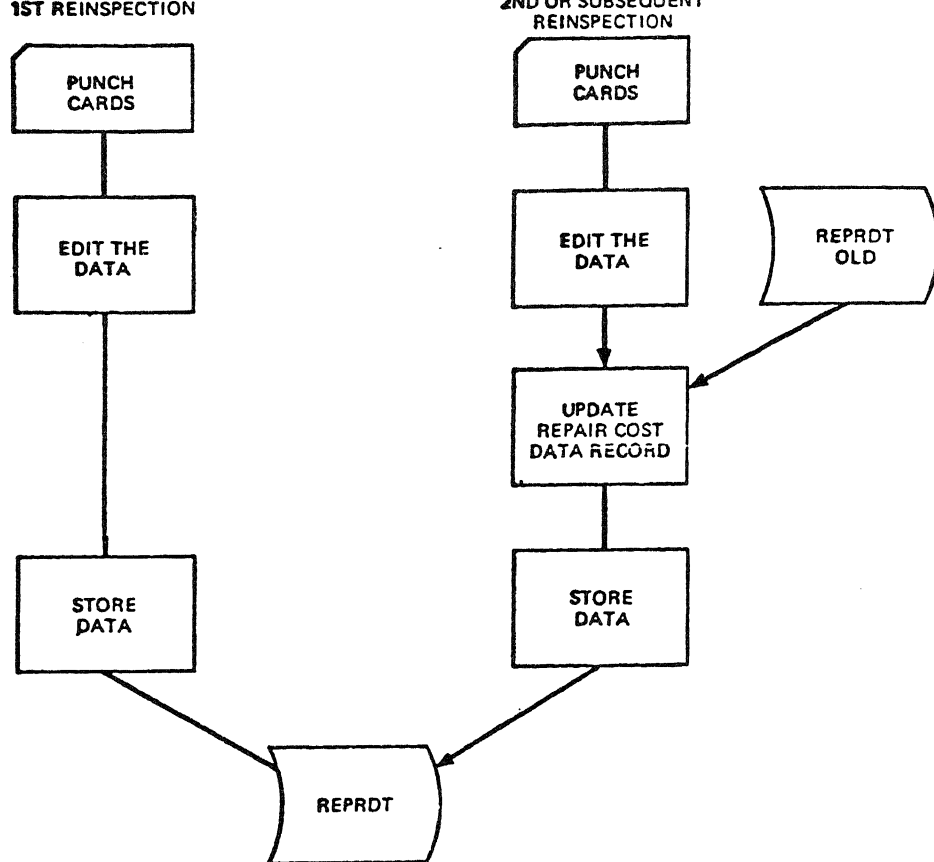


FIGURE 8.—Repair Cost Data Processing Module

Diagnostic Inspection Data Base and Report Generator

The information edited and processed was stored in the data base called DIAGDT (diagnostic data). The data are classified into the following categories:

- Key data
- Inspection data, such as date, odometer, etc.
- Vehicle characteristic data: make, model, etc.
- Diagnostic pass, fail, advise data.

The last category of data is subdivided into fifteen major subsystems to catch all items inspected on the vehicle. The combined data base contains information on a total of 111 items for each vehicle inspected. Each month, the following reports were produced for review and analysis:

Summary of Vehicles Inspected. This report summarized the inspection failure rate by periodic

cycle for a specific state. Included in the summary were the number and percentage of vehicles inspected, failed, and passed during the monthly report period. Also, pass/fail vehicle counts and percentages are reported for one, two, and three or more subsystems. Both treatment and control groups were included in the current and cumulative totals.

Vehicle Item Failures by Subsystem. This report summarized by item the inspection failures by periodic cycle for a specific state. The vehicle item failures and percentages are listed for both the treatment and control groups.

Advisory Pass Rates by Vehicle Subsystem for Treatment Group Only. This report summarized inspection advisories by periodic cycle for the treatment group. All subsystem advisories and percentages are listed for the current reporting cycle and cumulative cycle.

Engine-Related Outages and Consumer Advisories by Item Treatment Only. This report summarized the inspection advisories by periodic cycle for the treatment group. Included in this report are the subsystems' underhood items and engine analysis. The number of vehicle failures and percentages are printed for each item. Also, the state name and reporting period are printed in the heading.

Engine-Related Outages and Consumer Advisories by Item. This report summarized the inspection failures by periodic cycle for the subsystems' underhood items and engine analysis. The number of vehicle failures and percentages were printed for both the treatment and control groups.

Vehicle Failure Rates by Year. This report summarized the results for vehicle inspection by periodic cycle. The data was grouped by model year for treatment and control groups. The report shows the number of vehicles of a particular model year inspected, the number of those inspected that failed one or more items, and the percentage failing.

Vehicle Failure Rate by Subsystem. This report summarized the inspection failure rates by periodic cycle for a specific state. The vehicle subsystem failures and percentage of failures are summarized for both the treatment and control groups. Also, the failures are reported for the cumulative treatment and control groups.

Engine-Related Outages and Consumer Advisories by Subsystem Treatment Only. This report summarized the inspection advisories by periodic cycle for a specific state for the treatment group. The subsystems' underhood items and engine analysis are included in this report. Total vehicle advisories and percentages were printed for the current reporting cycle and the cumulative cycle.

Engine-Related Outage and Consumer Advisories by Subsystem. This table summarized the inspection failure rates by periodic cycle for a specific state, for the subsystems' underhood items and engine analysis. For each subsystem the number of vehicle failures and percentages are reported for both the treatment and control group.

Data Reduction and Processing

As the data was received and manually edited, a code was assigned to each data element for entering that element into the data base. In this manner, CSC

was able to process data from five different sites and unify the data into a single bank. Considerable time and effort was spent developing a system and the software to accommodate the uniqueness of the D.C. data. This required special handling and development efforts.

The inspection data for D.C. came from (1) regular inspection lane (control group) and (2) diagnostic lane (treatment group). The control group data were received on magnetic tape in a packed byte format and were processed in two steps: first, the data were unpacked; then, they were reformatted into (CSC) standard data format. The transformed data were then treated the same as data from Tennessee, Alabama, Arizona, and Puerto Rico.

The processing of treatment group data also required two steps, since the data, as received from the PDP-11 computer located onsite, were not compatible with the IBM 360 computer employed by CSC. As described earlier, the diagnostic lane data processing was designed by AVCO and has its own characteristics in addition to the standard PDP-11 computer system characteristics. Taking into account these special characteristics, CSC has designed a program that interprets the PDP-11 data and transforms them into IBM-readable data. Once this transformation is done, the data are reformatted into CSC's standard data base preprocessor format. Currently, the VIN numbers are not provided by D.C. and, therefore, a special version is designed to interpret the make/model code abbreviations used by D.C.

Vehicle Item Advisories by Subsystem for Treatment Group Only

This report summarized the results of vehicle inspection by periodic cycle for vehicles in the treatment group that received advisory/pass for an item. The data were presented at the item level. The report showed the number of vehicles receiving advisories for a particular item and the percentage of the total number of vehicles in the treatment group.

ASSESSMENT OF MOTOR VEHICLE DIAGNOSTIC INSPECTION

Impact on Safety

One of the objectives of the MVDI demonstration projects was to provide a comprehensive analysis concerning vehicle-in-use (VIU) standards and the sensitivity of rejection rates to changes in these standards. Degradation data were analyzed at the system and

component levels, and related quantitative data were analyzed by site. Life-cycle data were limited to the first, second, and third periodic inspections of approximately six month duration for each cycle. Items covered in the safety standards study include:

- Failure rate differences for the diagnostic versus the control group, and
- First to second to third periodic failure rate changes.

Although each project site was required to perform certain basic diagnostic inspections, they were allowed to expand the list of criteria, e.g., states or cities with PMVI programs were allowed to include mandatory system or component inspections. All projects also performed inspections of additional safety-related items not addressed by the federal VIU standard. These varied somewhat among the projects, and included headlamp function and aim, other lamps and reflectors, seat belts, body condition, glazing condition, exhaust system, fuel system, underhood and electrical items. The criteria common to all project sites as promulgated by NHTSA is expressed in Part 570, Vehicle In Use Inspection Standards, of Chapter V, Title 49, Code of Federal Regulations. The VIU standards address the brakes, steering system, suspension system, and tire and wheel components. These are the systems and components that vehicle safety research has shown to be safety critical. A listing of the standards addressed in Part 570 is presented below:

• Service brake system

- 570.5(a) Brake failure indicator
- 570.5(b) Brake system integrity
- 570.5(c) Brake pedal reserve
- 570.5(d) Service brake performance
- 570.5(e) Brake hoses and assemblies
- 570.5(f) Disc and drum condition
- 570.5(g) Friction materials
- 570.5(h) Structural and mechanical parts
- 570.6 Brake power unit

• Steering systems

- 570.7(a) System play
- 570.7(b) Linkage play
- 570.7(c) Free turning
- 570.7(d) Alignment
- 570.7(e) Power steering system

• Suspension systems

- 570.8(a) Suspension condition
- 570.8(b) Shock absorber condition

• Tires

- 570.9(a) Tire tread depth
- 570.9(b) Tire type
- 570.9(c) General condition
- 570.9(d) Damage

Table 1
Vehicle Reject Rates by Project Location
for the First, Second, and Third Periodic Inspections
(Composite of All Items Inspected)

Site	P1 Inspection (%)	P2 Inspection (%)	P3 Inspection (%)
Alabama	93.2	82.9	85.6
Arizona	91.9	89.6	84.9
Puerto Rico	90.4	64.9	*
Tennessee	47.4	37.8	31.5
Washington, D.C.	48.0	22.1	27.9
Average	74.2	60.7	57.5

* Sample too small to compute reject rate.

- **Wheel assemblies**

570.10(a) Wheel integrity

570.10(b) Deformation

570.10(c) Mounting

The control (nondiagnostic) group inspections performed at the Chattanooga, Tennessee, and Washington, D.C., projects did not include wheel removal to inspect brakes, and thus did not address Part 570.5(f), (g), and (h). Wheel removal to facilitate brake inspection was not a statutory requirement in these jurisdictions.

An analysis of the data from over 125,000 in-depth inspections (including reinspections after repairs) covering a 15-month period yields some startling statistics. On the average, 74% of the vehicles in the program failed the initial periodic inspection. In states without a mandatory PMVI program, over 90 percent of the vehicles failed the initial inspection (Table 1). It is encouraging to note that the safety and emissions systems of vehicles in the program show a 23% reduction in the reject rates for the relatively short period of the demonstration.

Furthermore, the reject rate decrease from the initial inspection to the third-cycle inspection is statistically significant to a high level of confidence. The values shown in Table 2 reflect inspection failure rates for the Federal VIU safety and emission systems criteria. Again, in all cases a significant improvement in the mechanical condition of the systems and components was realized from the initial (P1) to the final (P3) inspection. Analysis of the pass/fail rate data from the first and third periodic diagnostic inspections shows 57% improvement in the condition of the vehicle safety and emissions systems. In the safety critical brake system area alone, 35% of vehicles diagnosed

had unacceptable system or component degradation. This unusually high failure rate has substantial safety implications, as brake problems account for nearly half of the vehicular factors which caused accidents. However, it is noteworthy that the reject rates were steadily decreasing over the life of the demonstration. A low reject rate is a measure of the roadworthiness of a vehicle from the safety point of view. One final point that must be made is the fact that advisories, which are an important part of the long-term safety condition of vehicles, were not reflected in the above tables but could enhance safety under extended life cycle test conditions.

Impact on Emissions

In addition to periodic safety inspections, the demonstration projects were required to conduct emissions inspections pursuant to the criteria promulgated by NHTSA in consultation with the Environmental Protection Agency. The pass/fail levels for emissions were based on EPA recommendations and on comments from the private sector. As such, the criteria represent a fair balance between low and high rejection rates to avert adverse public reaction to the demonstrations. The compromise emissions criteria and test procedures provided for both the no-load or idle test and the loaded-mode test conditions. In each case two major air pollutants were measured—carbon monoxide (CO) and hydrocarbons (HC). The relative HC and CO emission levels determined under loaded-mode inspection were also used in diagnosing engine malfunctions.

The idle emissions inspection procedure required the observation of steady-state pollutant concentration. To pass the idle test exhaust gas concentrations, the emissions were required to meet the following values,

Table 2
Reject Rates for Vehicle-In-Use Safety and Emissions Systems

System	P1 Inspection (%)	P2 Inspection (%)	P3 Inspection (%)
Brakes	34.9	21.1	14.9
Alignment	18.7	11.8	6.8
Tires & Wheels	15.1	10.6	8.3
Suspension	11.6	5.9	3.7
Steering	6.5	5.0	3.4
Emissions	22.8	13.9	9.9

with the transmission selector positioned as recommended by the manufacturer for idle speed adjustment:

- 1967 and earlier model years (uncontrolled emission vehicles)
HC 1,200 ppm
CO 9.0%
- 1968 through 1973 model years (controlled emission vehicles)
HC 600 ppm
CO 7.0%

The loaded-mode emissions inspection procedure required the use of a chassis dynamometer. The vehicle to be tested was operated on the dynamometer with the transmission selector lever in the manufacturer's recommended position at any particular speed-load combination being tested. Automatic transmis-

sion-equipped vehicles were run in the "drive" position for the idle test. Under these test conditions the vehicle was required to meet the steady-state pollutant concentrations shown in Table 3 for the applicable weight class of the vehicle being inspected. To determine the applicable weight, 300 pounds were added to the vehicle's curb weight value as shown in Table 4. The demonstration sites had the option of testing by either the no-load or loaded-mode inspection methods. The methods used are shown in Table 5.

Although NHTSA did not issue standards concerning specific emission-related components and systems, the Guidelines for State Proposals suggested that the projects consider inspection of the PCV valve, air filter, idle speed, spark plug firing voltage, available coil voltage, coil/condenser oscillations, ignition point operation and dwell, ignition timing and variation,

Table 3
Exhaust Gas Concentration Values for Loaded-Mode Tests

1967 and earlier model years (Uncontrolled Emission Vehicles)		
High Cruise	Low Cruise	Idle
HC 900 ppm CO 4.5%	HC 900 ppm CO 5.5%	HC 1200 ppm CO 9.0%
1968 through 1973 model years (Controlled Emission Vehicles)		
High Cruise	Low Cruise	Idle
HC 450 ppm CO 3.75%	HC 450 ppm CO 4.25%	HC 600 ppm CO 7.0%

Table 4
Driving Cycle Speed-Load Combination

Curb Weight (plus 300 lbs)	1st High Cruise	2nd Low Cruise	3rd Idle
3,801 lbs and up 2,801-3,800 lbs 2,000-2,800 lbs	48-50 mph @ 27-30 hp 44-46 mph @ 21-24 hp 36-38 mph @ 13-15 hp	32-35 mph @ 10-12 hp 29-32 mph @ 8-10 hp 22-25 mph @ 4-6 hp	@ idle @ idle @ idle

Table 5
Emissions Inspection Methods Used by the Demonstration Projects

State	Emissions Testing Method
Alabama	Loaded Mode
Arizona	Loaded Mode
Puerto Rico	No Load
Tennessee	
Treatment Group	No Load and Loaded Mode
Control Group	No Load
Washington, D.C.	
Treatment Group	Loaded Mode
Control Group	Not Tested

Table 6
Average Emission Levels

Inspection Cycle	Loaded Mode						No—Load Mode			
	Idle		Low Cruise		High Cruise		Idle		2,250 rpm	
	HC (ppm)	CO (%)	HC (ppm)	CO (%)	HC (ppm)	CO (%)	HC (ppm)	CO (%)	HC (ppm)	CO (%)
1	292	3.98	216	1.29	206	1.44	309	3.20	248	1.29
2	259	3.79	190	1.90	180	1.04	311	3.63	219	1.41
3	223	2.74	173	1.02	172	1.38	264	3.35	159	1.19

vacuum advance condition, mechanical advance condition, dynamic cylinder balance, and manifold vacuum condition.

No project inspected all items suggested, and there was some variation among the projects. Most of the projects inspected the PCV valve, idle speed, spark plug firing voltage, available coil voltage, ignition point dwell, ignition timing and variation, and dynamic cylinder balance. Inspections of the battery and charging system were also frequently performed. Those projects that conducted loaded-mode emission inspections used the results in a "truth chart" matrix to further identify carburetion or ignition problems as the probable source of the high emissions.

Table 6 shows the average emission levels reported for the loaded and no-load modes for each of the inspection cycles. The combined average HC and CO levels were down 22% and 12%, respectively, from the initial to the final inspection. The composite failure rates for the emission tests shown in Table 2 were also reduced significantly, from 22.8% to 9.9%, over the program duration. Results of loaded mode testing show that:

- Idle test failures accounted for 60% to 80% of all emissions outages;
- CO failures accounted for 48% to 65% of all emissions failures;

Table 7
Fuel Economy Improvement Based on Before/After Tune-Up Data

State	Treatment				Control			
	Number of Vehicles	MPG Before	MPG After	Change (%)	Number of Vehicles	MPG Before	MPG After	Change (%)
Washington, D.C.	50	12,128	12,594	3.80	50	11.506	11.662	1.40
Alabama	14	15.980	17.080	6.90	28	13.750	14.640	6.50
Arizona	42	13.650	14.400	5.50	46	13.960	14.474	3.70
Tennessee	49	12.737	13.637	7.07	43	12.490	13.040	4.40
Composite	155	13.080	13.820	5.66	167	12.810	13.290	3.75
Total All Sources	322	12.940	13.550	4.70				

- Idle CO accounted for 26.5% to 48.7% of all emissions failures; and
- Idle CO and HC accounted for from 50% to 64% of all emission failures.

Program results support the claim that specific diagnostic information on the condition of the engine helps the industry to properly correct emissions. The information provided apparently assisted the repair industry in providing adequate repairs at reasonable cost. During the first inspection cycle, the rate of faulty emission repairs was about 25% for both the diagnostic and control groups. During the second cycle, however, the diagnostic group had a faulty emissions repair rate of only 11.5%, which was nearly 30% less than the 16.3% rate experienced by the control group.

In addition to the clean air benefits resulting from the reduced pollution reported by the data evaluation contractor, fuel consumption data under day-to-day driving conditions indicate a significant improvement in fuel economy (Table 7). The results are based on a representative sample of all model years and vehicle weight classes. The before/after tune-up analysis was conducted for all sites by model year, by weight, by

class, and by diagnostic versus control groups. The major findings were:

- All vehicles combined resulted in before/after tune-up fuel economy of 4.7%.
- Diagnostic group generally exhibited a greater improvement in fuel economy than the control group (nondiagnostic).

The encouraging fuel economy results based on participant fuel consumption before and after tune-ups were substantiated by a joint EPA/NHTSA audit of 57 vehicles enrolled in the Phoenix, Arizona, project. These vehicles were subjected to the standard EPA Federal Test Procedures (FTP) urban and highway driving cycle tests. As in the case of the owner-submitted fuel consumption data, the EPA tests results show an improvement of 4.9% in fuel economy for compact cars and a FTP composite of 5.3% for intermediate cars.

Conclusions drawn from these data are that periodic diagnosis followed by corrective maintenance reduced exhaust pollution levels of HC and CO, and significantly improved fuel economy for vehicles in the demonstration program.

Impact on Repairs

One measure of the impact on the repair process is an assessment of the capability of the repair industry to repair diagnosed deficiencies and the cost of such repairs. The capability of the repair industry to repair specific outages was determined by reinspecting each item initially rejected. The reinspection failure rate can be a direct numerical measure of the industry's inability to perform adequate repairs in response

to inspection results. A vehicle is considered to have failed reinspection if the repair of a defect was attempted unsuccessfully or if no repair was performed on the vehicle. The vehicle reinspection failure rates for the five diagnostic demonstration projects are shown in Table 8.

The rates are presented by project and by periodic inspection cycle. The values range from a low of 1.1% for the first-cycle D.C. control group, to a high of 50.0% for the first-cycle Alabama control group.

Table 8
Vehicle Reinspection Failure Rate (%)

Project	Period 1		Period 2	
	Treatment	Control	Treatment	Control
Alabama	49.2	50.0	40.0	47.7
Arizona	33.2	33.6	23.1	25.1
Puerto Rico	13.9	13.8	9.2	8.3
Tennessee	9.4	10.5	8.9	11.1
Washington, D.C.	3.0	1.1	2.9	4.2
Weighted Average	30.7	31.8	19.7	21.6

The objective of this task was to determine if detailed knowledge of the specific problem can facilitate correction and impact repair costs. The brake and emissions systems are particularly sensitive to the effect of diagnosis. Analysis showed that approximately 6% cost savings was realized from tune-ups and carburetor work for the group with diagnostic information. In other areas, only a marginal savings can be observed. Some of the true value of diagnostic inspection appears to be lost, either as a result of the short duration of the program or the dependence on the consumer and repair industry to effectively use diagnostic information. However, in spite of the modest cost benefits, the concept of an independent, objective diagnostic inspection with no vested interest in the actual repair process was well received by both the consumer and the repair industry. Program participants voluntarily spent approximately \$2.4 million on vehicle repairs, and many of them spent money for repairs that were clearly discretionary. Furthermore, a closer examination of the results indicate that

a vehicle owner armed with diagnostic information has a greater likelihood of receiving correct repairs, particularly for emissions systems. The distribution of repair dollars by subsystems is shown in Figure 9. Brakes, tires and wheels, emissions, and suspension systems account for two-thirds of the repair cost dollars. The average expenditure for vehicle repaired in response to inspection during the program was \$57.

CONCLUSION

The overall program results dealing with safety critical systems, emissions, costs, and benefits were positive. Although we have barely scratched the surface in our analysis of available data and information, there is much evidence to support the assertion that the concept of diagnostic inspection is viable and will benefit consumers by providing them with data and information on the condition of vehicles, which if used properly can result in:

- Safer vehicles,
- Reduced pollution,

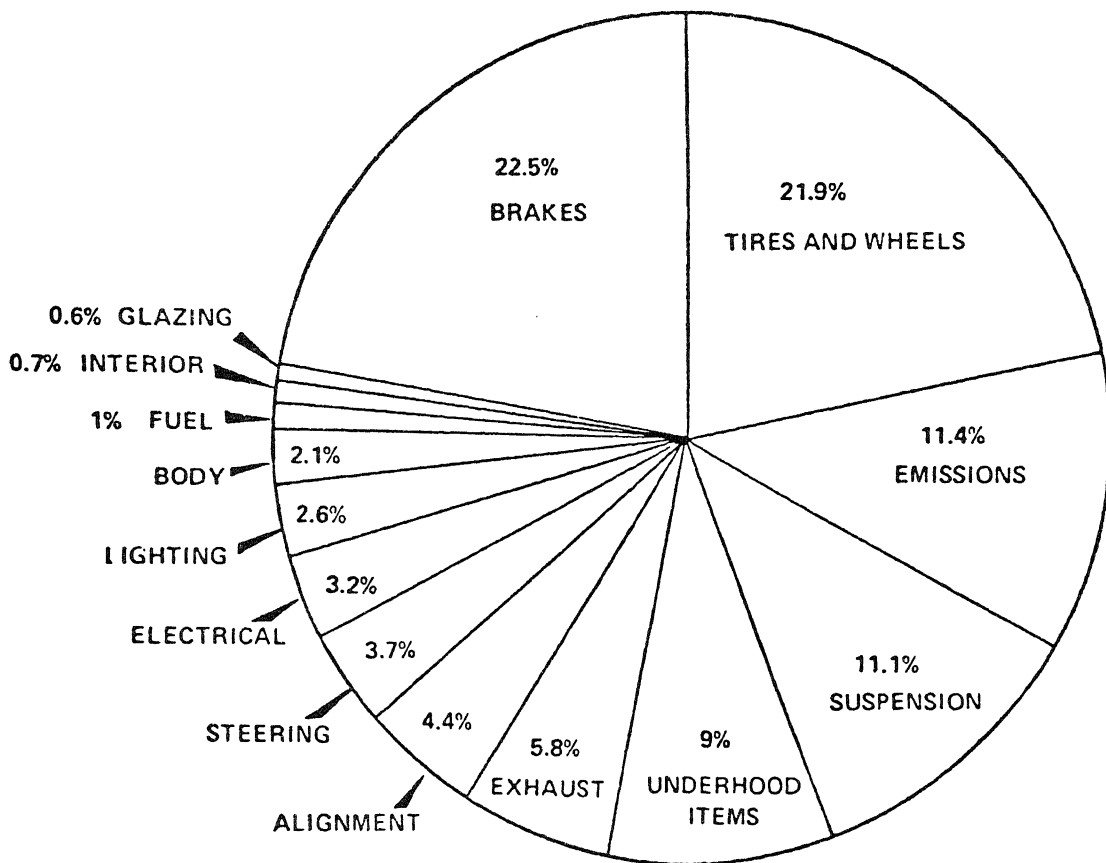


FIGURE 9.—Distribution of Vehicle System Repair Costs

- Improved fuel economy, and
- Generally lower repair and maintenance costs and/or improved repair quality.

Analysis of the pass/fail rates for the safety critical systems and components shows a statistically significant improvement in vehicle condition over the 15-month span of the program.

Major benefits were also identified and quantified for the emissions system—notably, a 5.7% cost savings was reported on tune-ups and carburetor work for the diagnostic group. In addition to the reduction in air pollution, the results of a before/after tune-up analysis based on a representative sample of all model year and vehicle weight classes participating in this program show a 4.7% improvement in fuel economy. Perhaps the most gratifying aspect of the demonstration was the consumer reaction to the diagnostic inspection program. A survey of consumer demographic atti-

tudes and experience conducted by a nationally prominent market research group shows that over 78% of a national sample of vehicle owners agreed that vehicle inspection should be required by law. When participants were asked if they would join a diagnostic inspection program again, 93% said they would. When asked about the amount they would be willing to pay for a diagnostic inspection, over 60% were willing to pay \$10 or more. Obviously, the concept of an independent, objective diagnostic inspection with no vested interest in the actual repair process was well received by both the consumer and the repair industry. Furthermore, the benefits of diagnostic inspection can be considerably greater by improving communication between the inspection facility and the repair industry. Since the consumer and the repair industry play key roles in the effective use of diagnostic information, further improvement in this critical communication link is highly desirable.

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ABSTRACT CITATIONS

SAMPLE ENTRIES

FORMAT OF ENTRIES IN HIGHWAY SAFETY LITERATURE

NHTSA accession number ----- HS-013 124

Title of document ----- **MAXIMUM BRAKE PEDAL FORCES PRODUCED BY
MALE AND FEMALE DRIVERS**

Abstract ----- The object of this research was to obtain data concerning the maximum amount of brake pedal force that automobile drivers were able to sustain over a period of ten seconds. Subjects were told to apply the brakes in the test car as they would in a panic stop, and to exert as much force as possible on the pedal over the entire ten second test period. A total of 84 subjects were tested, including 42 males and 42 females. The results indicated that there is a wide distribution of values which characterizes the pedal force that the subjects were able to generate. Male subjects produced generally higher forces than did females. Over half the women tested were unable to exert more than 150 lbs. of force with either foot alone, but when both feet were applied to the pedal, force levels rose significantly.

Personal author(s) ----- by C. R. VonBuseck

Corporate author (or author's affiliation) ----- General Motors Corp.

Publication date; pagination ----- 1973? ; 18p

Supplementary note ----- Excerpts from Maximum Parking Brake Forces Applied by Male and Female Drivers (EM-23) BY R. L. Bierley, 1965, are included.

Availability ----- Availability: Corporate author

NHTSA accession number ----- HS-018 924

Title of document ----- **NATURAL FREQUENCIES OF THE BIAS TIRE**

Abstract ----- The lowest natural frequencies of a bias tire under inflation pressure are deduced by assuming the bias tire as a composite structure of a bias-laminated, toroidal membrane shell and rigorously taking three displacement components into consideration. The point collocation method is used to solve a derived system of differential equations with variable coefficients. It is found that the lowest natural frequencies calculated for two kinds of bias tire agree well with the corresponding experimental results in a wide range of inflation pressures. Results of the approximate analysis show that the influences of the in-plane inertia forces on natural frequency may be considered small, but the influences of in-plane displacements are large, particularly on the natural frequency of the tire under low inflation pressure.

Personal author(s) ----- by Masami Hirano; Takashi Akasaka

Journal citation ----- Publ: Tire Science and Technology v4 n2 p86-114 (May 1976)

Publication date ----- 1976; 6refs

Availability ----- Availability: See publication

QUANTIFYING THE BENEFITS OF SEPARATING PEDESTRIANS AND VEHICLES

A comprehensive methodology has been developed for evaluating the social, environmental, and economic impacts of proposals for pedestrian facilities which will be of special interest to urban and transportation planners, and traffic safety specialists in state and local governments. Measurement techniques were developed for 36 variables that quantify all significant direct and indirect benefits of facilities separating pedestrians and vehicles. The methodology can be used to evaluate alternative facilities being considered for a single site or to establish warrants or priorities for a number of pedestrian facilities. This report, organized in identifiable elements to serve the needs of both practitioners and researchers, details applications of the methodology and presents step-by-step instructions to use the measurement techniques recommended for each of the 36 facility evaluation variables. The evaluation variables are: travel time; ease of walking; convenience; special provisions for various groups; motor vehicle travel costs; use of automobiles; signal/signing needs adjacent to facility; adaptability to future transportation development plans; impact on use of existing transportation systems; societal cost of accidents; accident threat concern; crime concern; emergency access/medical and fire facilities; pedestrian-oriented environment; litter control; density; climate control and weather protection; effects of air pollution; noise impacts of motor vehicles; health effects of walking; conservation of resources; residential dislocation; community pride, cohesiveness, and social interaction; aesthetic impact, and compatibility with neighborhood; gross retail sales; displacement or renovation required or encouraged by facility; ease of deliveries and employee commuting; attractiveness of area to business; public participation in the planning process; conformance with requirements and regulations; net change in tax receipts and other revenue; resulting changes in employment; change in the cost of providing community services; community activities; adaptability to future urban development plans; and construction period. The overall methodology and the extensive range of measured parameters provide a broad perspective on the design and use of pedestrian facilities.

by Ronald R. Braun; Marc F. Roddin
Stanford Res. Inst., Menlo Park, Calif.
Rept. No. NCHRP-189; 1978; 137p 99refs
Sponsored by American Assoc. of State Hwy. and
Transportation Officials in cooperation with Federal Hwy.
Administration. Research performed under NCHRP Proj. 20-
10.
Availability: TRB \$7.00

DELOREAN TEST PROGRAM [SPORTS CAR PROTOTYPE]

In recent testing sessions at the Transportation Res. Center (TRC) at East Liberty, Ohio, development work continued on the engineering prototype DeLorean DMC-12 car. The DMC-12 is a unique, gull-wing, two-passenger sports car which represents the second in a series of vehicles, the first being a fully-dressed show/compact car. The engineering prototype car tested at TRC was complete and was observed in the final phases of a series of development tests, the handling tests and

evaluations of roll and roll couple distribution. Several differences exist between the first and second versions of the DMC-12. The engine remaining in the rear is now located in line, behind the rear axle, from the original transverse location; the wheelbase has been shortened to accommodate the new engine location, and the radiator has been moved forward from its former rear-mounted position. External appearance, giving allowances for the differences between a development prototype and show car, remains the same, except for new, better looking wheels. The basic platform of the car is unique, and results in a strong, lightweight structure which can be produced from relatively inexpensive tooling. The structure is created by bonding together two forms produced by the Elastic Reservoir Molding (ERM) process. The complete body of the car consists of the upper and lower ERM structures, stainless steel body panels, and foam-filled bumpers. The front suspension is independent, incorporating Pinto uprights and upper A-arm; supporting it is a steel subframe which bolts to the main structure. A rear subframe supports the rear suspension and drive line, and bolts to the main chassis structure. The car has independent rear suspension with upper and lower A-arms, with two control links. The engine and transmission are the Volvo version of the aluminum, Renault-built, 163 CID (cubic-inch-displacement) V6 engine and the Renault five-speed manual transmission. The brake system will incorporate Bendix disc brakes on all four wheels. No power options will be used. Although there is still a long way to go before production starts in Northern Ireland, the test session observed indicates the DeLorean DMC-12 is well along.

by Charles R. Cantwell
Publ: Automotive Industries v158 n13 p89-91 (Sep 1978)
1978
Availability: See publication

BEARING BASICS. ROLLERS, BALLS, PINS, SHEELS AND BUSHINGS...EACH BEARING TYPE HAS ITS OWN JOB TO DO [MOTORCYCLES]

Bearings are intended to support and locate rotating mechanical bits (shafts). Bearing loads are basically thrust and radial loads. Thrust loads are always parallel to the shaft centerline, radial loads perpendicular to it; any other complex loading can be resolved by a combination of the two. The two great families of bearings are plain and rolling-element. Plain bearings are simply precise holes for the shaft to turn in; they may be base-metal on metal, bushed, or fitted with high-speed, steel-backed shell inserts. The rolling-element type includes all the many variations of ball, roller, and needle. Regardless of type, each supports the shaft under load and prevents metal-to-metal scuffing. All plain bearings must support their shafts on a hydraulic cushion of lubricant if they are to prevent metal-to-metal contact. To do their job they must be guaranteed a reliable supply of lubricant. The faster they are supposed to turn, the more critical this supply. Most roller-element bearings, even the most precise, create a certain amount of scuffing friction even if in theory they are intended to be frictionless. This friction can involve roller against race due to grinding inaccuracies, roller against cage (in caged bearings), roller against roller (in full-complement types), plus some inevitable scuffing of roller end against thrust face. A full-complement bearing is one in which the space between inner and outer races has been crammed with as many rolling elements (balls

or rollers) as it can hold. A fully-loaded rolling element bearing carries that load on a few elements at a time, and the ability of these few points to bear up under stress determines the ultimate load-carrying capacity of the bearing. When the capacity is exceeded, it causes brinelling or permanent deformation of either races or balls/rollers, with resultant shock loads that will cause disintegration at speed. Because these full-complement bearings place a maximum number of load-carrying points in a given space, they are best for stationary loading. The caged variety uses a thin, light floating shell to surround the balls/rollers, keeping them separated while minimizing scuffing. Caged bearings lose in load capacity, but gain in speed potential. Once caged or full-complement bearings have been chosen, there is still a large selection of shapes, a choice largely determined by the thrust/radial character of the expected loads. There are many types of rolling-element bearings because there are so many load/speed/lubricant combinations. In some applications grease will be used as the lubricant since it stays put, does not have to be renewed frequently, and accepts extreme-pressure loads. In the engine-transmission unit, oil must be used because of the heat loads and contaminants that must be carried away. Oil can be delivered to bearings by dip/splash, force-feed, and spray-mist methods. Generally, plain shell bearings, particularly high-speed/high-stress ones, require pressurized force-feed lubrication. Rolling elements require just enough lubricant to keep their elements wet, and can exist in a dip/splash environment (e.g. gearbox/primary drive use); if force-fed, they prefer oil in small doses, particularly a spray-mist. Be it plain or roller type each bearing is a tiny, mass-produced precision unit designed for specific lubrication requirements within a specific load/speed environment. A better appreciation of bearing design and operation promotes a better appreciation of the motorcycle and what lubricants it requires, where, and how often.

by Lane Campbell
 Publ: Cycle World v17 n11 p75-80 (Nov 1978)
 1978
 Availability: See publication

HS-024 392

ELASTOMERS IN DETROIT'S FUTURE [AUTOMOBILE APPLICATIONS]

In an effort to meet government fuel economy mandates, U.S. auto makers are looking at vehicle weight reduction as the most obvious way to increase gasoline mileage. Much of this weight reduction is being accomplished by replacing traditional metal parts with elastomeric or reinforced-plastic composite parts. The initial thrust of elastomers into automobile applications involved nonstructural parts such as soft fascia. The next generation of applications (in the 1980-1982 model years) will see nonmetallic components in structural use (motor mounts, driveshafts, door side beams, frame sections, and even wheels). For every pound of plastics used in a car, weight savings of 3/4 lb to 1 lb are realized. By 1985, the current plastics usage figure will more than double, to 280 lb to 350 lb per car. Broadly speaking, some 700 lb of weight has been pared from the average car to date; another 1250 lb must be shed by 1985 to attain the 27.5 mpg gasoline consumption figure. Elastomeric and engineering plastic materials are expected to make a 15% contribution to this weight reduction. Polymeric materials are also energy efficient in the manufacturing process. The downsizing of cars actually may reduce the amount of rubber in each auto, but rubbers will also be used as modifiers for plastics, etc. Powdered nitrile rubber is

finding new applications as a modifier for polyvinyl chloride in such applications as bumper strips, sight shields, and splash guards. Compounds based on EPDM are being used in engines because of high heat resistance; they also have a bright future in automotive weather stripping. Polyolefinic-based materials have found uses in a wide variety of automotive exterior applications (e.g. fender extensions) because of resiliency. A big future market could be silicone-based brake fluids, and fluorosilicones in tubing, seals, hose, diaphragms, and cups of smaller cars. Urethane foam has peaked as a passenger-car seating material; such use will decrease but total interior usage will remain about the same because of more protective padding. Outside the auto, urethane's future depends very much on successful development of machinery to permit reaction injection molding of urethane parts incorporating reinforced glass fibers. If reinforced reaction injection molded automotive fascia and exterior panels can be successfully produced, the economic advantages will cause a decline in EPDM and thermoplastic urethane usage for these applications.

by W. O. Murtland
 Publ: Elastomerics v110 n10 p35-40 (Oct 1978)
 1978; 11refs
 Availability: See publication

HS-024 393

THE HONG KONG BEAT [TRAFFIC SAFETY]

On average there are about 300 vehicles per mile of road in Hong Kong which makes it one of the world's highest traffic densities. The aim of the Traffic Branch of the Royal Hong Kong Police Force is to provide the highest possible degree of free and safe flow of vehicle and pedestrian traffic. The accident rate, however, continues to rise, reaching a total of 12,345 accidents and 15,749 casualties in 1976; 47.7% of these accidents were attributable to pedestrian carelessness. The prime location of pedestrian accidents was at road junctions and pedestrian crossings, particularly the uncontrolled type. Other causes of accidents are listed as driver carelessness, misjudgment, and speeding. Traffic statistics in Hong Kong are now fully computerized, and there is a permanent road safety exhibit to which schools organize trips. Older school students act as street crossing guards (3500 patrol members from 104 schools). The traffic law in Hong Kong is virtually identical to that in the U.K., the main difference being that there is no breathalyzer law (although there is no evidence to indicate that there is a drinking-driving problem). The police have the power to arrest a person who fails to produce a driver's license on demand. Hong Kong has certain inherent problems which create a heavy burden on the traffic situation (e.g. extensive subway construction, severe flooding during monsoons, typhoons). However, a major traffic safety problem is the standard of driving. A solution to the accident problem might be a more strict driver's license test.

by Ian D. Coupe
 Publ: On the Road v1 n2 p4-5 (Summer 1978)
 1978
 Availability: See publication

June 29, 1979

HS-024 397

HS-024 394

UNSOLVED PROBLEMS IN POLYMER DEGRADATION [COMMERCIAL RUBBERS AND PLASTICS]

This review highlights some of the major problems in polymer degradation which are relevant to the industrial application of polymers and the progress which has been made toward solving them. The following subjects are considered separately: degradation during polymer processing, initiation of thermal or photochemical degradation in the presence or absence of air, dependence of metal catalysis of oxidative degradation on the nature of the cation and of the substrate, inability of antioxidants and stabilizers to prevent degradation completely, the protection of unsaturated polymers against ozone degradation without loss in other desired properties, and the action of atmospheric pollutants on polymers. The degradation of commercial rubbers and plastics is exceedingly complex, since processing and small quantities of impurities or additives can interact and totally change the behavior of the substrate. It is not sufficient to examine the degradation of pure materials. The pure polymer may be studied as a baseline; but in order to obtain the full story, it also must be studied in the presence of known impurities or additives added singly and also in combination. This systematic approach is laborious and seldom used. The need for more realistic tests is now being recognized. Outdoor exposure combines the effects of ultraviolet light, heat, rain, ozone, nitrogen dioxide, and sulfur dioxide. A laboratory test should take all such factors into account. If a part is to be exposed to oil and air in the presence of heat, as it may be in an automobile, laboratory tests must examine the combined effects of these. The literature contains a wealth of information on the degradation of model compounds and pure materials, and copious empirical information on the behavior of commercial materials. The explanation of what happens in practice and, especially, in the production of commercial polymers which give close to ideal behavior, is much more elusive.

by J. R. Dunn

Publ: Rubber Chemistry and Technology v51 n4 p686-703 (Sep-Oct 1978)

1978; 106refs

Availability: See publication

HS-024 395

EFFECT OF ELEVATED TEMPERATURE ON THE UNACCELERATED AND ACCELERATED SULFUR VULCANIZATION OF NATURAL RUBBER

The effect of higher vulcanization temperature on the kinetics of vulcanization has been studied, and the changes in the vulcanizate structure with cure time has been followed in unaccelerated as well as in accelerated systems ranging from conventional to efficient vulcanization (EV). MDB (2-(morpholinodithio)benzothiazole) has the ability of being both a vulcanizing agent for polydiene rubbers when used without elemental sulfur and a delayed-action sulfenamide-type accelerator of sulfur vulcanization. Vulcanization systems grading from conventional to EV have been obtained by varying the ratio of sulfur to MDB. High cure temperature up to 180 degrees C seems to have no significant effect on the mechanism of unaccelerated sulfur vulcanization of natural rubber. In the case of accelerated systems, the conventional ones undergo more desulfurization and decomposition of the

initially-formed polysulfidic crosslinks at higher cure temperature. The EV systems show less dependence on cure temperature, and the main maturing reaction seems to be desulfurization of the polysulfidic crosslinks. The semi-EV system shows behavior intermediate between the conventional system and the EV one. Expectedly, the EV systems show better resistance to reversion at high cure temperature than the conventional and semi-EV systems.

by R. Mukhopadhyay; S. K. De

Publ: Rubber Chemistry and Technology v51 n4 p704-17 (Sep-Oct 1978)

1978; 16refs

Availability: See publication

HS-024 396

MOLDING OF RUBBER

The materials, methods, problems, and special treatments associated with the molding of rubber are surveyed, with emphasis placed on comparing the more established methods and materials with the newer reaction injection molding (RIM) method and associated materials. Rubbers with quite different rheological behavior are molded readily using various methods such as compression and injection for millable compositions, while the more recent RIM method is used for molding low-viscosity polyurethanes. A comparison of RIM with the more established methods shows advantages for the former, especially for high-modulus compositions. Molding problems such as porosity, shrinkage, and mold fouling are briefly reviewed along with means of alleviating these problems. A number of molding variables (part weight, viscosity, shear rate, time in mold, pressure in mold, Young's Modulus, shrinkage, thermal diffusivity, molding temperature) and their associated ranges are considered. The ranges vary significantly. The weight range of molded parts varies by about ten decades, while the range of thermal diffusivities for different rubbers and compositions is less than one decade. The ratio for in-mold times for different materials and methods is intermediate, varying by three decades. Both pretreatments and posttreatments are associated with molding rubber. For example, preheating off-the-road tires before molding compensates for low thermal diffusivity. Posttreatments permit modifying tire surface friction, altering and stabilizing tire dimensions, and improving tire flammability characteristics and other properties (e.g. fatigue life).

by J. G. Sommer

Publ: Rubber Chemistry and Technology v51 n4 p738-48 (Sep-Oct 1978)

1978; 91refs

Presented at joint meeting of Rubber Div., American Chemical Society, and Rubber Div., Chemical Inst. of Canada, Montreal, Quebec, 2-5 May 1978.

Availability: See publication

HS-024 397

SUMMARY STATISTICS OF THE NATIONAL RAILROAD-HIGHWAY CROSSING INVENTORY FOR PUBLIC AT-GRADE CROSSINGS. FINAL REPORT

A comprehensive statistical summary is presented of the characteristics for all public, at-grade railroad crossings in the U.S. (some 219,000) reported in the joint government/industry

National Inventory of Railroad Crossings as of Aug 1976. Information is presented in the following sections: introduction; organization, interpretation and updating of statistics; presentations of physical characteristics (location, surroundings, trackage, highway, warning devices, crossing); presentations of operational characteristics (train traffic, train speed, highway traffic); and miscellaneous data requested on Dept. of Transportation (DOT)-Assoc. of American Railroads (ARR) inventory form. Appended are the DOT-ARR inventory form, a glossary, a list of railroad company symbols and names, and a patent declaration. This information will be useful at the Federal, state, and local levels for determining effective allocation of crossing improvement funds and developing research and development, legislative, information, and education programs aimed at improving safety at crossings.

by John S. Hitz, ed.
Transportation Systems Center, Kendall Square, Cambridge,
Mass. 02142
FRA-RR733
Rept. No. DOT-TSC-FRA-77-10; PB-271 334; FRA-OPPD-77-
8; 1977; 155p
Rept. for Mar 1976-Feb 1977.
Availability: NTIS

HS-024 398

**VEHICLE DYNAMICS TERMINOLOGY. SAE J670E.
REPORT OF VEHICLE DYNAMICS COMMITTEE
APPROVED JULY 1952 AND LAST REVISED JULY**

... Terminology--SAE J670 has been expanded to encompass terminology related to directional control of motor vehicles. Revisions also have been made to update the original terminology. An alphabetical index is appended to facilitate location of definitions. A numbered outline of the individual terms according to category (mechanical vibration-qualitative, mechanical vibration-quantitative, vibrating systems, components and characteristics of suspension systems, vibrations of vehicle suspension systems, suspension geometry, tires and wheels, kinematics: force and moments notation, directional dynamics, and aerodynamic nomenclature) precedes the correspondingly-numbered definitions. Words and phrases appearing in a definition which themselves are defined elsewhere in the volume are denoted by italics.

Society of Automotive Engineers, Inc., Vehicle Dynamics
Com., 400 Commonwealth Drive, Warrendale, Pa. 15096
1978; 25p 3refs
SAE Handbook Supp. SAE Recommended Practice.
Availability: SAE

HS-024 399

**ASSESSMENT OF INJURY CRITERIA IN ROADSIDE
BARRIER TESTS. FINAL REPORT**

The evolution of present human tolerance injury criteria, as utilized in the testing and analysis of roadside barriers, is summarized. These criteria are reviewed in the light of pertinent literature, and a new set of injury criteria are recommended based on average motor vehicle deceleration in G units over the duration of impact (a) and the velocity change up to the instant of contact of the occupant with the occupant compart-

ment (the secondary impact) in m/sec (ΔV). Criteria for recommended tolerance limits for fatal or irreversibly-disabling injuries are as follows: lap and shoulder belts (longitudinal, 12 ΔV , 25 a; lateral 12 ΔV , 25 a; vertical, 3 ΔV , 12 a) lap belts only (longitudinal, 12 ΔV , 20 a; lateral, 6 ΔV , 20 a; vertical 3 ΔV , 12 a); and unrestrained (longitudinal, 12 ΔV , 20 a; lateral, 6 ΔV , 20 a; vertical, 3 ΔV , 10 a). It is recommended that terms such as peak acceleration, maximum acceleration, and onset rate, be abandoned or standardized with precise meanings. An interdisciplinary team should be assembled to conduct extensive studies, following the principles established by Swearingen and Michalski, and make simulation runs in laboratories to correlate field injury data. An effort should be made to make a simple or even a crude mathematical model analysis along the lines established by Payne and Kornhauser. A rational injury criterion should be established. All that is necessary is the velocity change and duration of the event. The accelerometer trace need not be recorded, and the controversial filtering procedure can be eliminated. This would permit concentration on the duplicating runs to test reproducibility of the velocity traces. Too conservative an approach to barrier safety would require a set of tolerance limits much lower than necessary. Even though many existing designs can satisfy these limits, their adoption might have a tendency to disqualify a perfectly safe barrier of rigid type design, such as the concrete barrier. From an economic point of view, such a barrier is cheaper in the long run since it requires infrequent maintenance. This economic factor may justify a lower safety factor to be applied to the values used. There is very good ground, however, to be conservative in barrier crash studies, especially when the vehicle is redirected. In this case, the vehicle may be travelling at 75% of impact speed or higher, and even a very brief loss of consciousness on the part of the driver could have very grave consequences.

by Michael Chi
Chi Associates, Inc., 1011 Arlington Blvd., Suite 316,
Arlington, Va. 22209
FHWA-5-4-0154
Rept. No. FHWA-RD-75-74; PB-281 543; 1976; 54p 30refs
Availability: NTIS

HS-024 400

**THE ECONOMIC USE OF ELECTRIC ROAD
VEHICLES IN A CHANGING ENVIRONMENT.
ELECTRIC VEHICLE DEVELOPMENT GROUP
INTERNATIONAL CONFERENCE (2ND), 23RD-24TH
MAY 1978**

A compilation of papers (and discussions thereof) given at a Sheffield, England, meeting is presented. The factors involved in the implementation of large numbers of high-performance electric vehicles (EV's), drawing upon the experience to date of those now operating delivery and public transit EV's, are examined. Papers are presented in sections dealing with public passenger transport, and high-performance delivery vehicles.

Electric Vehicle Devel. Group, 59 Colebrooke Row, London, N1 8AF, England
Rept. No. PPL-15; 1978; 103p refs
Includes HS-024 401--HS-024 412. Supported by the National Freight Corp., National Bus Co., South Yorkshire Passenger Transport Executive, International Union of Public Transport, Electrical Res. Assoc., The Chartered Inst. of Transport, International Road Transport Union, Greater Manchester Passenger Transport Executive, Lead Devel. Assoc., Electronics and Power, and Greater London Council.
Availability: SAE

HS-024 401

ESTIMATED SUPPLIES OF TRANSPORT FUELS TO THE END OF THE CENTURY

World supply of transportation fuels both in the medium term (1985) and at the end of the century (2000) is projected. (The intervening period is assumed to follow a gradual transition between the situations projected at these two dates.) There is likely to be sufficient oil available in the world in 1985 to meet full demand and more than enough to satisfy premium uses such as transport. The real price of oil in 1985 is unlikely to be more than marginally lower than today. It could well be the same though a significant increase is possible. Of the alternatives to oil for transportation purposes, fuel syncrude is very unlikely to play a significant role in 1985. Apart from the long lead times required for large-scale syncrude manufacture to be established, in order for syncrude production to be economic, it would require an oil price approaching twice the present real level. Availability of electricity will be a function of national rather than worldwide conditions. Within the U.K., in particular, there should be sufficient off-peak electricity available in 1985 to provide for a significant expansion of electricity as a transport fuel. The price for off-peak electricity will be influenced heavily by the price of fuel used to generate it; in 1985, the fuel used to generate the marginal unit of electricity could be either coal or oil. It seems likely that world oil production will peak in the 1990's and decline thereafter, ceasing to be the world's marginal energy source. In these circumstances, the demand for oil will have to adjust to whatever supply is available. The most likely mechanism for bringing about rationing of this oil demand will be an increase in its price. Although oil supplies may be constrained, there should be sufficient oil available, whether from conventional or unconventional (e.g. oil shale, tar sand, syncrude) sources to meet the premium demands (e.g. petrochemicals, transportation), leaving some left over for bulk heat and electricity generation. This suggests that the price of oil will be set as a result of competition with other fuels in the nonpremium oil markets. Real crude oil price in the year 2000 could be between two and three times that of today. The supplies of transport fuels other than oil will, as in 1985, tend to be determined on a national basis. In the U.K., the end of the century could witness an upsurge in demand for off-peak electricity as natural gas supplies decrease, causing electric vehicles to compete much more for the available supplies of electricity.

by J. M. Barber

Department of Energy, U.K.

Publ: HS-024 400 (PPL-15), "The Economic Use of Electric Road Vehicles in a Changing Environment. Electric Vehicle Development Group International Conference (2nd)," London, 1978 p7-13

1978; 15refs

Conference held in Sheffield, England, 23-24 May 1978.

Availability: In HS-024 400

HS-024 402

AN OPERATORS REQUIREMENTS AND OPERATIONAL EXPERIENCE WITH BATTERY ELECTRIC BUSES AND A CONSIDERATION OF FUTURE DEVELOPMENTS [ENGLAND]

The experience of the South Yorkshire Passenger Transport Executive (S.Y.P.T.E.), England, in operating a range of battery electric buses since Oct 1975, is discussed. The bus operator's ideal requirements for any vehicle and how they apply to

the Yorkshire situation are outlined; these desired items include a self-contained vehicle, all-route capability, rangeability to cover all schedules, maximum carrying capacity, reliability, simple maintenance, easy ingress/egress, and one-person-operation. The history and development of the S.Y.P.T.E. electric bus operation, technical descriptions of the electric buses (Chloride Silent Rider, Lucas electric midibus, and Crompton electric buses), bus service requirements and performance, and measured performance data (energy consumption, availability, operating costs, and driver/passenger reactions) are discussed. Operator's requirements and operational experience to date are used to make projections for the next generation of battery electric vehicles, EV's (full-size buses using sodium-sulfur batteries). Other types of straight and hybrid EV's which are considered worthy of further investigation and/or development are battery/electric (electric traction batteries/overhead wires), diesel/electric (basic diesel-powered vehicle/electric traction for environmental reasons), and electro/diesel (straight EV (with or without line dependence)/diesel for range extension). The trolley bus will have a future if battery systems fail to come up to present expectations. The biggest drawbacks to the trolleybus are inflexibility due to dependence on overhead wires, its propensity to dewire, overhead maintenance problems, and cost. A trolleybus with larger traction batteries or in electro/diesel form could largely overcome the inflexibility.

by D. Scott Hellewell

South Yorkshire Passenger Transport Executive, Sheffield, England

Publ: HS-024 400 (PPL-15), "The Economic Use of Electric Road Vehicles in a Changing Environment. Electric Vehicle Development Group International Conference (2nd)," London, 1978 p14-23

1978

Conference held in Sheffield, England, 23-24 May 1978.

Availability: In HS-024 400

HS-024 403

TOWARDS A MORE VERSATILE PUBLIC PASSENGER TRANSPORT SYSTEM BASED ON EXPERIENCE WITH THE LEYLAND/BOSCH/CHLORIDE BUS AT RUNCORN, CHESHIRE [ELECTRIC BUS, ENGLAND]

Performance data and operational suitability of an electric bus which has been in use for almost five years on the reserved bus lanes in Runcorn, England, vs. the National Bus Co.'s standard diesel-powered public transit bus from which it was converted are outlined. In addition to the low availability of the electric bus, other factors which make this vehicle a nonviable means of public transportation include high initial cost and operational limitations (e.g. speed too low for use on main roads (38.9 mph), limited range (60 mi)). The electric bus project must be altered to become economically viable. A new approach must be taken to provide an electric vehicle that has improved availability, lower purchase cost, lower operating cost, improved operational suitability, longer vehicle life, and reduced downtime for maintenance and other engineering operations. The vehicle must start as a completely new design; the adaptation of existing bus designs incurs penalties, narrowly channeling traction motor design and installation, and incurring weight penalties by virtue of construction designed to accommodate engine, gearbox, fuel tank, retarder, etc. Interchangeable trailers with fixed battery or of a type permitting battery change are not acceptable because of weight penalties, use of road and garage space, and tire cost, as well

as lack of stability in some situations. Battery stowage must be on board the vehicle, palletized and easily removable. Increased battery capacity per unit weight is needed, but careful redesign of existing battery types would help. The owners must be willing to run the vehicle a similar mileage each year of its life. The present group average is 37,500 miles/year over 15 years. Corrosion protection must be provided; the vehicle, without battery, must be lighter; all items whose presence is dictated by mechanical propulsion should be eliminated (traction motors could be of the hub type, thus eliminating rear axle final drive and differential and the rear axle). There must be consideration of the duo and hybrid in view of the wide variety in types of bus operation. Since some 30% of National's operation is in urban areas, the duo bus would have an application if some overhead installation were acceptable. Greater distances would need an internal combustion engine (ICE) and a hybrid for improved flexibility. Operating engineers believe that a contribution to fuel economy could be made with ICE vehicles by recovering the vehicle's kinetic energy during retardation and storing it in hydraulic accumulators, for later "topping up". Valuable lessons have been learned from the electric bus project to date, and the current electric bus will continue to be operated in Runcorn at least until the end of the first battery life.

by A. Gurley

National Bus Co., England

Publ: HS-024 400 (PPL-15), "The Economic Use of Electric Road Vehicles in a Changing Environment. Electric Vehicle Development Group International Conference (2nd)," London, 1978 p24-8

1978

Conference held in Sheffield, England, 23-24 May 1978.

Availability: In HS-024 400

main inexperienced. Major auto companies have not made significant commitments to an EV program. The state-of-the-art assessment clearly showed the immaturity of the U.S. EV industry, but also showed that where appropriate consideration has been given to EV capabilities which then have been matched to a suitable application, results have been very successful. Another requirement of the Act is to publish performance standards for the vehicles to be procured in the demonstration. Published in the Federal Register 10 Feb 1978, these standards call for a minimum range of 50 km for passenger vehicles, a minimum acceleration capability of 0-50 km/h in 12 sec; and the ability to meet all Federal motor vehicle safety standards. They must maintain 88 km/h for 5 minutes, climbing a 15% grade at 25 km/h, and have a useful battery life of 15,000 km or 12 months. Standards for commercial vehicles are slightly lower in some cases. At first there will have to be some government financial aid. The Act gives permission to acquire foreign-made vehicles during the first two years of the demonstration, recognizing that much of the state-of-the-art technology for today's EV's is available overseas, not in the U.S. The Act also calls for an accelerated research and development program in electric and hybrid vehicles. Estimates for market penetration of EV's in the U.S. range from between 5 and 15 million vehicles by the year 2000 (a saving of 50 to 150 million barrels oil/year).

by R. A. Purple

Publ: HS-024 400 (PPL-15), "The Economic Use of Electric Road Vehicles in a Changing Environment. Electric Vehicle Development Group International Conference (2nd)," London, 1978 p33-5

1978

Conference held in Sheffield, England, 23-24 May 1978.

Availability: In HS-024 400

HS-024 404

THE UNITED STATES ELECTRIC AND HYBRID VEHICLE PROGRAM

The age of electric vehicles (EV's) is coming, and the U.S. is committing significant resources to a broad-based program aimed at accelerating the commercial realization of this oil-saving transportation mode. In 1976, the Congress passed the Electric and Hybrid Vehicle Research, Development, and Demonstration Act which specifies, among other things, that two large vehicle demonstrations be carried out. The first required purchase or lease of 2500 vehicles, to be ordered by Jun 1978; the second was for 5000 vehicles, to be delivered by Mar 1981. The results of the first few months of the Dept. of Energy's (DOE) state-of-the-art and state-of-the-industry evaluations confirmed doubts that these objectives could be met, particularly the first. The capability of industry to produce that many vehicles of high enough performance and reliability to meet even the most modest acceptable performance standards was extremely questionable. Because of this, the Act was significantly revised by the Congress on 25 Feb 1978. The demonstration program now calls for an annual incremental addition of vehicles to the program for fiscal years (FY) 1978 through 1984 (between 200 and 400 vehicles in FY 1978, at least 600 in FY 79, at least 1700 in FY 1980, and at least 7500 during FY 1981 through FY 1984). The Act now gives DOE much more flexibility in the timing and the size of demonstration orders, allowing for subsequent orders to be phased with significant technological developments and providing for a more orderly expansion of industrial capability. The number of U.S. manufacturers of on-the-road battery-powered vehicles during recent years has been about 18, in the

HS-024 405

OPERATIONAL EXPERIENCE WITH THE SILENT KARRIER DELIVERY VAN AND A REVIEW OF MARKETING PROSPECTS RELATED TO TOTAL COSTS [ELECTRIC VEHICLE, ENGLAND]

An outline history of National Carriers Ltd.'s involvement with electric vehicles (EV's) in delivery service is discussed in terms of the consortium formed to develop an electric delivery van (National Freight Corp. (parent company of National Carriers), Chrysler (U.K.) Ltd., and Chloride Technical Ltd. (U.K.)) and the initial vehicle specification, the Silent Karrier Mk I prototype, the Silent Karrier Mk IA production vehicle, the government's "London Goes Electric" program, and the Mk IA specification. The assessment of the in-service operation of the Silent Karrier Mk IA is discussed from the driver's, the customer's, the engineer's, the accountant's, and the fleet operator's viewpoints. Within its operational specification (full traffic compatibility in urban and suburban operation with respect to acceleration, top speed (65 kph), and hill climbing ability; 1.75 tons payload capacity; and range on single charge (urban delivery conditions) of 80 plus km), the Silent Karrier has been a practical commercial vehicle. To make it a more attractive form of transportation, a number of improvements are desirable; these include an extension of its range to about 115 km for the short term, increase in the payload to 2 tons for the short term, development of on-board charging, a more accurate and reliable device for monitoring and displaying energy available in battery, reduction in the ini-

tial price differential, and greater drivetrain efficiency and better aerodynamics.

by B. R. Hayward
National Carriers Ltd., England
Publ: HS-024 400 (PPL-15), "The Economic Use of Electric Road Vehicles in a Changing Environment. Electric Vehicle Development Group International Conference (2nd)," London, 1978 p36-43
1978
Conference held in Sheffield, England, 23-24 May 1978.
Availability: In HS-024 400

HS-024 406

POTENTIAL USE OF VANS POWERED BY ELECTRIC WHEEL MOTOR UNITS

Background of the recent decision by the Cambridgeshire County Libraries system (England) to purchase an electric mobile library is outlined; and the potential of the particular electric vehicle (EV) selected, the Creusen WW 6564 S (made in Holland), is discussed in terms of the vehicle's technical features. The basic requirements of a bookmobile provide almost the ideal specification for EV's; the fixed and regular mileage can be related to the required battery capacity, and the advantages of EV's (e.g. low operating costs, simple maintenance, longer working life, noiseless and hygienic working conditions, and low energy consumption) are already known. The Creusen WW 6564 S, formerly used only as a traveling shop, is an 8-m size vehicle similar in shape to bookmobiles already operated by the Cambridgeshire library system, and contains a counter, public access door, adjustable shelving, interior lighting and heating as standard components. Its payload is 3000 kg, more than adequate for the library needs. The current low maximum speed of about 25 kph can initially be overcome by operating the vehicle in an urban residential situation where high speed between stopping points is not essential. A prototype high-speed vehicle is expected within the next year or two, at which time replacement vehicles may be obtained. The Creusen WW 6564 S is driven by electric wheel motor units which allow for a low-profile chassis with a completely level upper face; a variety of bodies can thus be constructed on a modular system. The library project has generated interest from local authorities. The vehicle is reliable, having been in use in Holland for more than 15 years, it is economically viable, and can accrue savings over conventional vehicles despite the higher initial costs.

by R. Brown; L. Creusen
Cambridgeshire County Libraries, England; Elektro-Mechanische N.V., Netherlands
Publ: HS-024 400 (PPL-15), "The Economic Use of Electric Road Vehicles in a Changing Environment. Electric Vehicle Development Group International Conference (2nd)," London, 1978 p44-6
1978
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HS-024 407

ECONOMIC PROSPECTS FOR ELECTRIC TRACTION FOR PUBLIC TRANSPORT OPERATION [LONDON, ENGLAND]

Outlined are three phases in future world oil supply and demand and how they will affect the use of the private automo-

bile and the type of propulsion system used for public transportation operations, with particular reference to the economic prospects for the battery electric bus by the London Transport Executive. The three phases of oil supply and demand are envisaged as follows: up to 1985-1990, oil supply exceeding the demand and prices accordingly staying constant (given the cartel) in real terms; 1985-1990 to 2000 plus, demand exceeding supply and real prices rising; and 2000 plus, physical rationing introduced, with oil supply eventually being reserved for top-priority users only. The technological options for alternative petroleum fuels considered are liquid natural gas and liquid petroleum gas; alternative engine types are the gas turbine engine and the Stirling engine. The use of a battery electric bus vs. a diesel bus is compared in economic terms. The analysis suggests that electric bus operation would increase London Transport's costs by at least 12m pounds per annum. A change to these vehicles would, therefore, only become worthwhile if hydrocarbon fuel costs rose, in real terms, by a factor of at least 2.2 (and possibly as much as 4 times if allowance is made for the likely increase in electricity prices and other factors). If real oil prices begin to increase in the early 1990's, it is quite possible that they will rise rapidly particularly if, as seems likely, oil-producing countries begin to ration supplies. On this basis, it is reasonable to postulate that battery buses may begin to come into their own around the turn of the century, which is not too far in the future considering that current purchases of the present generation of London buses will continue until the mid 1990's, and that there are a number of technological operational problems associated with the battery bus that need to be solved. Further developments which might modify the introduction of the electric bus include improvements in battery technology (e.g. sodium-sulfur cell), and the development of a hybrid system, part battery/part trolley.

by David Quarmbay
London Transport Executive, England
Publ: HS-024 400 (PPL-15), "The Economic Use of Electric Road Vehicles in a Changing Environment. Electric Vehicle Development Group International Conference (2nd)," London, 1978 p53-7
1978; 5refs
Conference held in Sheffield, England, 23-24 May 1978.
Availability: In HS-024 400

HS-024 408

AN OUTLINE INVESTIGATION OF A HYBRID (COMBAT) TROLLEY BUS [ELECTRIC BUS]

The design and operation of a battery/trolley hybrid electric bus, the COMBAT (Combined Overhead Mains and Battery), are analyzed. The concept of the COMBAT bus is one of a double-deck vehicle with an on-board lead-acid or sodium-sulfur battery with a limited range but a road performance in terms of acceleration (0.85 m/sec/sec) and payload (80 passengers) matching present-day requirements. This limited range then is extended theoretically to infinity by charging the battery in its working environment via current collectors from an overhead or roadside electrical supply. The external supply pick-up would occur mainly along a selected section of the bus route, probably intermediate between the inner and outer terminals. Supplementary supplies could be envisaged at bus stops or at terminals. The selected route section ideally should be common to a number of bus routes so that its utilization is high. A single-deck bus based on this concept, the DUO-Bus, has been undergoing trials in West Germany. An outline impression is presented of the technological and economic feasibility and the advantages and disadvantages of employing

COMBAT buses for passenger transport operations in cities and suburbs. A hybrid battery/trolley bus transport system could be set up mainly using commercially available equipment. Where such equipment does not exist "off-the-shelf", e.g. automatic homing pantographs and rapid battery-charging systems, an assessment of the feasibility of producing such equipment with present-day technology is provided. The analysis is concerned mainly with vehicles having energy storage in lead-acid batteries. The broad implications of setting up a COMBAT bus transport system in two areas of England, Reading and South West Manchester, is considered. From this investigation it is seen that the main problem areas are rate of charge acceptance (possible to achieve a charge rate of 4%/min or more for up to 85% battery capacity vs. 2%/min assumed in this study), battery life (unknown factor under conditions of rapid charge and discharge), automatic homing and retracting current collector (design not yet precisely described), and effect of harmonics and voltage surges (incomplete knowledge of the extent of their effects for this particular application). It is likely that the COMBAT bus could meet the requirements of most urban bus systems. However, as with all existing and proposed electric buses, the increased initial capital cost will reduce the enthusiasm of bus operators.

by M. Bradford; D. E. Knights

Electrical Res. Assoc. Ltd., England

Publ: HS-024 400 (PPL-15), "The Economic Use of Electric Road Vehicles in a Changing Environment. Electric Vehicle Development Group International Conference (2nd)," London, 1978 p58-64

1978; 7refs

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HS-024 409

OPERATIONAL DATA AND RUNNING EXPERIENCE IN THE CITY OF ESSLINGEN [GERMANY] OF THE "DUO-BUS" [ELECTRIC BUS]

A development program for a battery/trolley hybrid electric bus for public transportation sponsored by the West German government, the DUO-Bus project, is described. The development has been carried out since 1974 by Robert Bosch G.m.b.H., Daimler Benz A.G., Dornier System G.m.b.H., and Varta-Batterie A.G. The DUO-Bus is so planned that it can drive either with the electrical overhead wires or separated from these wires. When driving off-wire, the energy is taken from a traction battery, whereas, when driving on-wire, the traction energy and the capability for recharging is drawn from the overhead wires. This makes the DUO-Bus more flexible than the conventional trolley bus. The first DUO-Bus prototype has been running successfully in public transport in Esslingen, West Germany, since Dec 1976. The single DUO-Bus drives along a trolley bus line that is 8.5 km in length. Battery power is used in one direction; in the other direction, the wires are used, at the same time allowing for battery recharging. From the viewpoints of operation and economy, the advantages and disadvantages of the DUO-Bus have become apparent: excellent serviceability, performance, and noise level; energy consumption almost equal to that of a conventional trolley bus; heavy weight requiring a special registration for 18 tons admissible overall weight; air cooler for battery insufficient in summer; maintenance of battery requiring very intensive work; life time of battery approximately one year or

about 50,000 km; and total operating costs, including capital costs, approximately 1.4 times those of a comparable diesel bus. Based on the results achieved to date, further development of the DUO-Bus will involve building two types of buses, one with an improved battery and one with an alternating electro/diesel (without battery) propulsion system. Two battery and three electro/diesel DUO-Buses are being built, to be used on a typical DUO-Bus route in Esslingen starting in 1978. As a further step, an extension of the overhead wires from Esslingen main station to Nellingen, and utilization of more than 10 extra electro/diesel buses, are planned for the early 1980's.

by E. O. Dietrich; K. Sahn

Dornier System G.m.b.H., Friedrichshafen, Federal Republic of Germany; Stadtsicher Verkehrsbetrieb Esslingen, Federal Republic of Germany

Publ: HS-024 400 (PPL-15), "The Economic Use of Electric Road Vehicles in a Changing Environment. Electric Vehicle Development Group International Conference (2nd)," London, 1978 p65-71

1978; 4refs

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HS-024 410

ELECTRIC ROAD VEHICLES IN A CHANGING ENVIRONMENT

For the foreseeable future, at least, the level of oil consumption will continue to be determined more by short-term interests of individual consumers and suppliers, reinforced by the political strength they represent, than by the long-term interests of mankind. This is by no means the political environment which favors the introduction of a new, challenging technology to the private car market such as the electric vehicle (EV). With respect to the physical environment, there has never been a more favorable time for the introduction of EV's. It is widely accepted that EV's have less impact with regard to air pollution, noise levels, and fuel consumption for a given level of travel demand, than their petroleum-powered counterparts. Provided the energy-density and collision-hazard problems of hybrid and battery-powered vehicles can be overcome, the case for their widespread use (at least for commercial and public transport purposes) would seem to be strong. However, until the EV can offer adequate performance, safety, and reliability within a competitive market price, the external benefits to the environment and to energy policy are unlikely to tip the balance. A means of altering the present situation, as in other instances where long-term marginal costs to society are not adequately reflected in prices, is to seek to adjust the tax structure. So long as half the tax burden on vehicle owners (in the U.K.) is fixed (i.e. unrelated to vehicle use), the perception of fuel price as a determinant of consumption will be negligible. To bring about the desired degree of fuel economy, whether by reduced vehicle mileage or by cutting specific fuel consumption of vehicles, requires the abolition (for a start) of the annual vehicle license charge and the 10% special car tax and their transfer to the form of a consumption tax on fuel which bears relation to its resource value in the long term. Such changes would possibly raise the funds necessary for EV demonstration projects. A better understanding of the interaction between activities and travel demand is necessary; a more behavioral approach to planning could be encouraged by government. The "sheltering" of EV technology by government is important (e.g. leniency in construction and use regulations, "pump priming" of the secondary technology

gies, etc.). As much research effort should go into studying the social-political climate needed for successful EV introduction as goes (at present) into its technical development.

by P. J. Hills
University of Newcastle upon Tyne, England
Publ: HS-024 400 (PPL-15), "The Economic Use of Electric Road Vehicles in a Changing Environment. Electric Vehicle Development Group International Conference (2nd)," London, 1978 p77-9
1978; 13refs
Conference held in Sheffield, England, 23-24 May 1978.
Availability: In HS-024 400

HS-024 411

TRANSHIPMENT DEPOTS--A RETAILER'S APPROACH [PROSPECTS FOR ELECTRIC DELIVERY VEHICLES, MARKS AND SPENCER LTD., U.K.]

Marks and Spencer Ltd., a chain of 253 department stores operating in the U.K., is described in terms of its history and operating principles, changes in physical distribution systems during the 1970's, and future development in store operations and administrative systems including physical requirements in delivery vehicles. In terms of switching from its use of conventional road vehicles for delivering goods to the various stores from several regional depots, the company is looking at the possibility of using electric vehicles because of their environmental advantages and in view of future oil availability. Marks and Spencer has set out its vehicle requirements as follows: a trailer between 28' and 33' long, capable of carrying 15 tons of merchandise; an ability to deliver at least twice a day to a location within 60 miles of the depot, without any loss of performance or lengthy refueling; reliability in order to meet strict delivery schedules; and a speed compatible with town, country, and highway operation which will enable the vehicle to move quickly and safely on its routes. To carry out full operational trials, the company will require the next generation of EV's, those that are larger, faster, and with longer range. The challenge is left to industry.

by A. D. Archdeacon
Marks and Spencer Ltd., U.K.
Publ: HS-024 400 (PPL-15), "The Economic Use of Electric Road Vehicles in a Changing Environment. Electric Vehicle Development Group International Conference (2nd)," London, 1978 p80-3
1978
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Availability: In HS-024 400

HS-024 412

SOME EXPERIENCES WITH ELECTRIC VEHICLES [TRANSSHIPMENT OF PARCELS, NETHERLANDS]

Van Gend and Loos N.V., a Dutch company involved in the transshipment of railroad parcels, is discussed in terms of its operations, vehicle fleet, driving staff, and operational costs in relation to expanding its electric vehicle (EV) utilization. At present, the company has 300 electric forklifts, and five electric delivery vans of a 1966 design which have a capacity of only 7.8 cu m, a payload of 1310 kg, and a maximum speed of 30 kph. Van Gend and Loos currently is in the market for an EV with a maximum speed of about 50 kph and sufficient acceleration. The need for the development of standard high-per-

formance electric vehicle batteries for mass production is emphasized as being essential to achieving a lower purchase price for EV's.

by J. P. Grootes
Van Gend and Loos N.V., Netherlands
Publ: HS-024 400 (PPL-15), "The Economic Use of Electric Road Vehicles in a Changing Environment. Electric Vehicle Development Group International Conference (2nd)," London, 1978 p84-6
1978
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HS-024 413

THE PREDICTION OF CHOICE RESPONSE TIMES FOR PICTOGRAPHIC SYMBOLS [MOTOR VEHICLE CONTROLS AND DISPLAYS]

Two experiments were performed to determine the relationship between psychological dimensions and choice response times (RT's) to pictographic symbols for motor vehicle controls and displays. In the first experiment, 20 subjects estimated, for both early (on the first response) and late (after 1000 trials) practice, the time required to locate a pictogram in an array subsequent to having been given its name. Subjects also made magnitude estimates for the detectability, discriminability, complexity, and communicativeness of 19 symbols (seat belt, charging circuit, choke, horn, fuel, coolant temperature, engine oil, front hood, rear hood, front fog lights, rear fog lights, parking lights, ventilating fan, lower beam, upper beam, turn signal, windshield wiper, windshield washer, and hazard warning). In the second experiment, RT's were collected for 16 subjects in a 16-alternative, forced-choice task similar to that described to subjects in the first experiment. It was found that responses could be grouped into four epochs: the first response to each symbol, the second response to each symbol, responses 3 through 10, and responses 11 through 60. The ordering of symbol RT's for the first and second response was clearly different from other responses. In all epochs there were large differences among pictogram RT's. Correlation data indicate that early in practice meaningfulness is important whereas late in practice detectability and discriminability are important. Several regression models of choice RT were developed in which the magnitude estimates served as the independent variables. Using as few as two or three estimates, in excess of 60% of the RT variance could be accounted for in most cases. It was found that a good pictogram is detectable; it is a bold, filled, solid, simple image with few details. A good pictogram is discriminable from all others in many ways. Not only does it not share a contour with others but its interior features are also different. It is shaded where others are not and vice versa. Its lines flow in different directions from other symbols. Finally, a good pictogram is meaningful. It looks like the function it is supposed to represent and, where possible, its action is shown.

by Paul Green
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NIOSH-5T01-0H00161-3; NIMH-MH-23767
1977; 66p 51refs
Sponsored in part by National Safety Council's Howard Pyle Fellowship for Safety Res.
Availability: Corporate author

HS-024 414

INCENTIVES AND DISINCENTIVES FOR RIDESHARING: A BEHAVIORAL STUDY

A sample of just under 800 commuters in the metropolitan Washington, D.C. area was surveyed in order to determine what leads them to share rides or to drive alone. In phase 1, 21 group dynamic discussion panels (not restricted to commuters or employed persons) were formed to generate hypotheses about people's perceptions, attitudes, and behavior with regard to car pooling. From the issues raised and attitudes discovered, a survey questionnaire was developed for phase 2, which was administered personally to 516 commuters, both car poolers and solo drivers. The behavioral hypotheses about ride sharing that were confirmed by the survey then were tested in phase 3 to develop strategies for increasing car pooling. Five general categories of commuters emerged from the research: dedicated car poolers with an active interest in advancing the mode (may be used effectively to recruit new members for their own pools, as well as to establish and support community opinions favoring car pools), marginal present car poolers (currently car pool but may drop out easily for a variety of minor reasons or might not continue to car pool if current pool ended, pose a challenge to car pool matching and maintenance), uninformed or passive potential car poolers (attitudes varying from eagerness to mild interest, many not knowing how to get in car pool or too passive, likely to be a rewarding target population), marginal anti-poolers who would become involved only if incentives highly appropriate for them were provided or particular disincentives were removed (considerable possibility for increasing ridesharing), and dedicated opponents or confirmed solo drivers who for independent reasons refuse to consider car pooling (would be waste of money to promote car pools to this group). Six factors considered critical for car pooling are cost, time, convenience, parking, car pool lanes, and social dynamics. A disaggregated approach is necessary for car pool programs; they should concentrate on appeals appropriate for particular segments of the population. Motivations for and problems connected with car pooling vary according to past car pool experience, occupation, age, income, sex, auto availability in the household, length of commute, etc. Successful programs must be based on thorough knowledge of the local scene. In general, promising targets include drivers with long commutes, those with regular working hours, persons over age 30, and commuters from households in which at least two adults are employed full time. A major hindrance to car pooling is poor communication; an active, personalized outreach system is needed (e.g. local-site car pool coordinators, and "How to Car Pool" booklet).

by Joseph B. Margolin; Marion Ruth Misch
Federal Hwy. Administration, Washington, D.C. 20590
1978; 137p 122refs
Availability: GPO, stock no. 050-003-00327-1

HS-024 415

LOW-FOGGING PLASTICIZERS FOR AUTOMOTIVE INTERIORS

Windshield fogging is caused by volatile plasticizers being evaporated from the vinyls used in car interiors, condensed and deposited on interior glass surfaces. The fogging is unsightly, difficult to remove, and hazardous because of glare and decreased visibility. The introduction of plasticizers based on linear alcohols greatly decreased the fogging, by offering

lower volatility while maintaining the necessary low-temperature flexibility of the vinyl compounds. To identify some of the parameters involved in plasticizer fogging an oil-immersion fogging test method was employed. The program was not directed at producing a finished coated fabric to meet manufacturer specifications. The ultimate goal was to design new plasticizers which fogged less than currently available materials to meet newer, more stringent auto manufacturer specifications and yet retain the desirable features of linear plasticizers with a minimum price differential. The plasticizers studied were made from a series of linear (over 99%) alcohols produced from aluminum, hydrogen, and ethylene and having even-numbered carbon chains. The alcohol designation represents the chain lengths present. C810 alcohol is a blend of 43% C8 and 57% C10 alcohols; a blend of 30% C8 and 70% C10 alcohols is designated C810CG. For blends containing linear C12 and C810 alcohols, the % of C12 is given following a hyphen, e.g. C812-15 is a blend of 15% C12 and 85% C810. Adding the letter P designates a phthalate ester made from an alcohol blend, e.g. C812-15P indicates the phthalate ester made from the C812-15 blend. It was felt that the most reasonable approach would be through upgrading the commercial C810 plasticizer. An acceptable ester was achieved by two approaches: adding a higher molecular weight alcohol to the existing C810 blend, and by increasing the level of the C10 alcohol in C810 alcohol. A series of phthalate esters was made by blending C12 alcohol with C810 alcohol, and coesterifying with phthalic anhydride. The degree of fogging is directly related to the amount of the more volatile components of the plasticizer; for the C810/C12 alcohol derived esters, the components are P88 and P810. The fractions of the volatile portions can be decreased by blending in a non-volatile plasticizer such as a linear dilauryl phthalate, a polymer plasticizer or a trimellitate. The volatility of the plasticizer shown to decrease with increasing C12 alcohol used in the coester. The experimentation has resulted in the good low fogging plasticizer candidate C812-15P. In addition, a blend 30% C8 and 70% C10 alcohols (C810CG) was esterified. This blend had the effect of lowering the P88 content from 23% to 10%, and gave a plasticizer with an oil-immersion fog value of 75 compared with 77 for the C812-15P. Tables show the reflectance values for five commercially available plasticizers and properties of low-fogging plasticizers, and the dependence of plasticizer volatility on coesterified C12 alcohol.

by J. L. Irvine; S. E. McGuire
Publ: Plastics Engineering p35-8 (Feb 1978)
1978
Availability: See publication

HS-024 416

THE EFFECT OF MOTORCYCLISTS' HIGH-VISIBILITY AIDS ON DRIVER GAP ACCEPTANCE

As part of a motorcyclist conspicuity research program, an experimental methodology studied driver behavior towards a moving motorcycle in a traffic environment. It was necessary that drivers be unaware of their involvement in an experiment and that a measure of their response to the presence of a motorcycle be observed without stopping them. Driver gap acceptance behavior was used as such a measure. Gap acceptance is based on the distribution of gaps between moving vehicles that a driver waiting at a junction will accept to move into. This measure has been widely used to investigate such things as conflict rate, intersection capacity and behavior prediction. At the two roadway sections studied, the use

either a fluorescent orange jacket by the motorcyclist or the use of dimmed motorcycle headlights (daylight conditions) did not have a significant effect on the gap acceptance behavior of motorists when compared with the behavior towards a control motorcycle (rider wearing dark clothing, no headlights used). While the presence of the high-visibility aids did not produce a detectable change in driver behavior, it must not be presumed that the use of such aids will have no benefit in the traffic situation. The experimental method was successful in presenting the conditions of interest in a natural traffic environment in a controlled manner, and unbiased gap acceptance data were obtained. If present methodology is considered for future gap acceptance behavior work, the use of traffic detector loops should ease and speed analysis whilst maintaining data accuracy.

by C. Kirkby; P. G. Stroud

Publ: Traffic Engineering and Control v19 n8-9 p401-3 (Aug-Sep 1978)

1978; 9refs

Sponsored by Transport and Road Res. Lab., Vehicle Safety Div. (England).

Availability: See publication

HS-024 417

THE GREATER LONDON 'RIDE BRIGHT' CAMPAIGN--ITS EFFECT ON MOTORCYCLIST CONSPICUITY AND CASUALTIES

The Greater London Road Safety Unit selected motorcycle (including motor scooters and mopeds) conspicuity as the topic for their annual publicity campaign in 1976; riders of powered two-wheeled vehicles were encouraged to improve their conspicuity by wearing bright clothing, preferably of fluorescent material, and by switching on headlights during the daytime. The campaign lasted from 28 Aug to 31 Oct 1976 and consisted of advertising on the London Broadcasting Co. and Capital Radio independent stations; posters placed on lampposts at the roadside and on public buildings; leaflets distributed to motorcyclists by Road Safety Officers of the 26 London boroughs participating, through garages, motorcycle dealers, factories, polytechnics, special events, etc., and by the Metropolitan Police; and giveaway items (e.g. combs, pens, keyrings, selected as being articles useful to motorcyclists and likely to be retained, each bearing the campaign slogan "Day or night—ride bright"). The increased use of headlights in the daytime and the wearing of distinctive clothing brought about by the campaign has been maintained 12 months after. Comparison of driver behavior before and after the campaign shows highly significant increases in the number of motorcyclists using their headlights during the day and also wearing distinctive clothing. The simple chi-squared test using dark accidents as the control indicates that, while there has been an increase of 6.8% in motorcycle casualties during daylight hours, the increase of 14.9% at night has been much larger. Using the dark trends as a control, a significant (2.5% level) drop of 7.0% has been determined for daytime motorcycle casualties from what would have been expected had the campaign not taken place. The reduction from the expected total was found to be 5.7% (not significant) for casualties at uncontrolled intersections, a particular accident type at which the campaign was aimed. An 'S' ratio test showed a reduction of 4.1% for motorcycle casualties involving a two-wheeled motor vehicle and pedestrian or another vehicle in the daylight from the expected total. From the results it seems reasonable to claim that some benefit to

motorcycle casualty trends has resulted from the change in motorcyclist behavior.

by N. Lalani; E. J. Holden

Publ: Traffic Engineering and Control v19 n8-9 p404-5, 407 (Aug-Sep 1978)

1978; 2refs

Availability: See publication

HS-024 418

BICYCLE SAFETY BECOMES BIG BUSINESS

The "ghost rider" concept of teaching children that they as bicyclists are invisible to motorists is now being taught in programs in every state. The teaching concept began in 1971 when Police Sergeant Dave Burn, then Community Relations Officer of the Garden Grove (Calif.) Police Dept., was assigned to do something about the doubling of bicycle-involved traffic accidents in one year. A 27-man committee was formed to devise a system covering protection against theft, legislation to toughen laws, education, and bike licensing and registration. The theme "ghost rider" was chosen and a 16-page booklet was developed by the board of education, parks and recreation, fire department, Chamber of Commerce, service clubs, PTA, Educational Aids of Long Beach, and several Orange County law enforcement agencies. Since then, Educational Aids has expanded the program to include rodeo kits, teacher lesson plan guides, lecture visual aids, flip charts, overhead projector transparencies, lecture slides, registration and license forms, violation notices, rules of the road posters, safety check cards, and publicity kits. There are currently 67 million Americans who ride bicycles, the majority under the age of 16, the age group at which the safety program is aimed. Children are taught traffic laws which pertain to bicyclists, bicycling safety tips, how to give bikes safety checks, and bike protection. In addition, bicycle rodeos are held which give the youngsters a chance to show their skills in balance, braking, signaling, control over an obstacle course, mounting and dismounting, and turning in a small space. Most "ghost rider" programs are administered by schools under the direction of law enforcers, with financial backing usually coming from civic and fraternal organizations.

by Vella C. Munn

Publ: California Highway Patrolman v42 n8 p14-5, 65 (Oct 1978)

1978

Availability: See publication

HS-024 419

KEEP YOUR CHILD SAFE WHEN YOU DRIVE

The following safety guidelines are offered for the protection of children in automobiles: carry children in the back seat if possible; fasten everyone's seat belts before starting the car; put groceries and other packages in the trunk; never leave small children alone in the car; be ready for emergencies (e.g. keep in the car a first-aid kit, large flashlight, a reflective warning signal, a fire extinguisher rated for gasoline and electrical fires, and a compressed air container for flat tires); learn to control skidding; practice defensive driving (think ahead, anticipate moves, be ready to take evasive action, and thus avoid situations requiring violent braking or acceleration); do not drive a malfunctioning car; and try to prevent distracting

bickering among children (take toys and car games along to keep youngsters occupied).

by Kathleen Cruzic

Publ: California Highway Patrolman v42 n8 p10, 51 (Oct 1978); 1978

Availability: See publication

HS-024 420

IS THIS YOUR DAY TO DRIVE? BIORHYTHMIC CYCLE

A study of 14,000 drivers has shown that 6 out of 10 severe auto accidents and violations occur at critical periods during drivers' biorhythmic cycles. Male drivers tend to have more accidents on critical days of their emotional cycle, when their ability to respond to dangerous traffic situations created by other drivers is reduced. Women have more problems on their critical days in their physical cycle, twice as many accidents as would be expected normally. Young drivers had 69% more traffic violations on their upswing critical day in their physical period, pointing to overenthusiasm. Older drivers had their worst problems on their downswing critical days, pointing to fatigue which would affect them more than younger drivers. Biorhythm is the theory that each person's life is affected by the interaction of three internal biological cycles, i.e. physical, emotional, and intellectual. During a high intellectual period (the first half of a 33-day-long cycle), alertness, concentration, and reasoning powers operate more effectively than during the second or lower half of the cycle. The physical cycle goes through a high and a low every 23 days and the emotional cycle is 28 days long. A critical day occurs when a cycle crosses from a high to a low period, or vice versa. Personalized biorhythms can be charted. Denver's Yellow Cab Co. has established a biorhythm safety program, and issued computerized biorhythm charts to its drivers with cautions marked on critical days. If a driver has a double critical day (when two cycles reach a critical day at the same time), he is advised, though not required, to switch his driving day with another driver. On triple critical days, the driver can take the day off. Over one-half of the company's accidents in 1975 occurred on critical days. Even though it is not known if the biorhythm program was the reason for the decrease in the company's accident rate during 1976 (1975 having been the company's safest year), it is known that the program has made the drivers more cautious.

by Bruce W. Most

Publ: California Highway Patrolman v42 n8 p26 (Oct 1978); 1978

Availability: See publication

HS-024 421

DEVELOPMENT OF ABSTRACT MEASURES OF DRIVER COGNITIVE STEREOTYPES

During a human factors evaluation of the Melbourne (Australia) area's Metropolitan Intersection Control Programme (Meteon) in 1976, both fixed site observations and a forced-choice questionnaire survey of the affected population were made. The questionnaire utilized principally a paper and pencil analog technique in devising stimulus items which sampled some of the same categories of intersection conflicts and high-risk mid-block decision problems that were observed in the field setting. The results showed that after experience with

the traffic control program, the questionnaire responses were influenced in the same manner and direction as overt behavior in the life situation, although to a lesser degree. With a view toward potential application as a low-cost predictive technique by which driver adaptability to a change in traffic control practices might be anticipated, or as a diagnostic tool by which maladaptive response stereotypes might be identified, it was decided that further development of the technique was warranted. Further research has resulted in a Driver Decision Questionnaire which incorporates several dimensions missing from the Metcon Questionnaire and suspected to be the source of a stronger impact of system experience on driving performance as compared with cognitive responses. These dimensions are control sequence, enroute traffic, centerline marking, and security of the road ahead as well as number to be overtaken, immediate control environment, and threat from the side roads. A trial administration of this questionnaire has shown significant discrimination of cognitive responses on all of these dimensions except centerline marking. Effective differentiation of anticipatory response dispositions, or cognitive stereotypes, with implications for ability to adapt to changes in the control environment, also was demonstrated. It is felt that continued development and validation of this technique is warranted.

by Robert K. McKelvey

Monash Univ., Human Factors Group, Clayton, Vic. 3168, Australia

Rept. No. HFR-8; 1978; 36p 10refs

Sponsored by Commonwealth Dept. of Transport (Australia).

Availability: Department of Transport, Road Safety Information Service, Box 1839Q, G.P.O., Melbourne, Vic. 3001, Australia

HS-024 422

A SYSTEM FOR THE AUTOMATIC ANALYSIS OF VEHICLE MOVEMENTS AT INTERSECTIONS

Analysis of vehicle movements at intersections continues to be of significant interest in the study of road user behavior. A flexible system is described that collects data such as speeds, headways, and gap acceptance on each arm of an intersection. An array of inconspicuous vehicle detecting switches is employed through a direct interface to a minicomputer. A real time data logging program stores the incoming data on a digital cassette unit. The hardware design of the detector system is very adaptable and can be used in conjunction with any minicomputer or microprocessor through a standard serial interface. Each detector in the array is connected to an encoder unit. These encoders in turn are interconnected in series by single-pair lead wires to form a 20 mA-current loop data path. A unique code is transmitted for each detector every time it is struck by a vehicle wheel. An outline is given of the design of the real time computer program for data logging and a step-by-step description of the algorithm employed in the program for the automatic reduction of the raw data. The system has been tested in the field by simultaneous application to the arms of a "Tee" intersection and its viability demonstrated.

by William K. Mare

Monash Univ., Human Factors Group, Clayton, Vic. 3168, Australia

Rept. No. HFR-7; 1978; 50p 4refs

Sponsored by Commonwealth Dept. of Transport (Australia).

Availability: Department of Transport, Road Safety Information Service, Box 1839Q, G.P.O., Melbourne, Vic. 3001, Australia

HS-024 423

'79 SNOWMOBILES--IMPROVED COMFORT, HANDLING, PERFORMANCE

Engineering and design aspects of the 1979 model year snowmobiles are highlighted. A new model is the Blizzard 9500 (Bombardier Ski-Doo), a high-performance (approximately 100-mph top speed) trail sled with a 437-cc, two-cylinder, two-stroke liquid-cooled engine. Instead of circulating through a radiator, the coolant passes through aluminum extrusions in the tunnel above the track. Snow and air thrown against the extrusions by the track dissipate the engine's heat. The 9500 chassis has a deeper tunnel to allow for more suspension travel. The 9500's water-cooled engine puts out in excess of 90 hp at the crankshaft. A tamer sled is the 5500, but its air-cooled, 498-cc, twin-cylinder, two-stroke piston-port engine speeds to well over 70 mph. Both sleds' bodies underwent extensive wind-tunnel testing to improve handling at high speed, and to keep wind off the driver. The 5500 has an air-cooled muffler (also on Citation model) which is intended to keep undercab temperature at an acceptable level, and at the same time, reduce the complexity of construction necessary to shield the engine from the heat. On all of Bombardier's Everest and Blizzard models, the rear of the ski has increased curvature making it easier to pull the machine backward; a flatter attack angle at the front of the ski allows the ski to climb on top rather than push the snow in front; and a convex-shaped ski underside allows snow to be thrown out in a horizontal spray. The Trail Cat is a new Arctic Cat model with a long-travel suspension (7 in travel front and rear); both front and rear suspensions use a shock-inside-a-coil-spring arrangement; and front skis are independently sprung. The Suzuki 340-cc, twin-cylinder engine is 15 lb lighter. John Deere's Trailfire is leaner (364 lb) and lower (centerline of crankshaft 10 1/2 in off the ground) than any of its predecessors. Suspension travel has been increased, and seats are thicker for more ride comfort. The high-strength low-alloy steel chassis withstands collision with a rock or tree stump better than an aluminum chassis. Thermoplastic rubber is used to help prevent breakage. The major thrust for Polaris has been in the suspension area with increased travel (from 2 3/4 in to about 5 in on some models). New from Yamaha is the 3000 Enticer, a performance sled (85-mph top speed) that uses a large-displacement (540-cc) engine designed to operate below peak capacity (helping to reduce noise and increase mpg). Kawasaki models for 1979 are generally unchanged except for styling. Scorpion offers a 440-cc Whip with a new, longer-travel suspension (about 5 in) and a new hemi-head. Bombardier's other trademark Moto-Ski features basically the same lineup as Ski-Doo, but with fewer models. Moto-Ski's Grand Prix Special is equivalent to the Ski-Doo 550 with fan-cooled muffler.

by Ray Hill
Publ: Popular Science v213 n5 p50, 52, 54 (Nov 1978)
1978
Availability: See publication

HS-024 424

THE AUTO-EMISSIONS MESS. HOW DID WE GET THERE? WHERE ARE WE GOING?

Some of the controversy surrounding legislation governing automobile emissions in the U.S. is examined. In 1976, Congress set stringent limits for exhaust emissions in the 1980's. It is estimated that 1981 model year cars will emit about 90% less

pollutants than pre-control cars, at a cost of \$8 to \$11 billion. The emission-control system of the 1980's will be built around the three-way catalytic converter which will dispose of the three principal automotive pollutants, i.e. hydrocarbons (HC), carbon monoxide (CO), and nitrogen oxides (NOx). Automakers have established a pattern of first insisting it is impossible to meet the deadlines for emission-control standards, and then announcing the deadlines could be met, when it became apparent that legislators were not going to change their position. The pattern started in 1963 when the California legislature passed a law requiring emission-control systems on all new cars in the state one year after such a system was certified as practical. In Mar 1964, Detroit said it would not have systems available until the 1967 model year. Two months later, California certified four systems made by independent companies; whereupon, Detroit said it could have devices ready by the 1966 model year. In 1970, Congress passed a 90% across-the-board reduction in HC and CO by 1975, in NOx by 1976. Again, the auto industry said that these standards could not be met, reversing its stand later, and agreeing that an oxidizing catalytic converter (which takes care of only HC and CO) was feasible. The industry has subsequently requested and been given more leeway in producing cars with three-way converters. General Motors has acknowledged that the company misread public sentiment about pollution control, and was trying to achieve it at the least possible cost. To the automakers the catalytic converter now looks like an incredible gamble that paid off despite heavy odds. In a single year (1975), GM cars achieved a 28% increase in fuel economy over the 1974 models which had been significantly detuned to meet earlier standards. Industry also claimed that the large volume of cars (and number of models) produced in the U.S. caused problems that foreign manufacturers did not face. Major scares associated with the converters were that they would cause fires because of excessive heat, and that they might transform airborne sulfur into sulfuric acid and sulfates, more dangerous than the pollutants eliminated by the devices. Both proved groundless. Still controversial is the question of the degree of health benefits associated with reducing auto emissions; more research is needed to clarify this issue. Studies on the health/pollution relationship are hampered by the difficulty in determining and monitoring air pollution levels, and the imperfect definition and detection of illnesses believed linked to chronic exposure to relatively low levels of pollutants. Two philosophies exist about safeguarding human health, one (the philosophy now in control) is maximum practicable protection of health, and the other is maximum return for the money in health benefits.

by Edward Edelson
Publ: Popular Science v213 n5 p64, 66, 68, 70, 72, 74 (Nov 1977)
1977; 2refs
Availability: See publication

HS-024 425

RELATIONSHIPS BETWEEN EXHAUST SMOKE EMISSIONS AND OPERATING VARIABLES IN DIESEL ENGINES

A study was undertaken to relate air-fuel ratio (A/F), fuel injection timing, and engine speed to exhaust smoke levels and performance of the diesel engine. Supercharged and turbocharged inlet air conditions were used to investigate the applicability of the derived relationships under these conditions. Variance in fuel type was also studied. It was found that A/F,

fuel injection timing, and engine speed have significant primary and secondary effects upon the level of smoke emission from diesel engines. Selection of proper A/F, fuel injection timing, and engine speed can provide dramatic reduction in smoke level while retaining or improving engine performance. While operating with supercharged air intake conditions, the relationships between smoke level and A/F, injection timing, and speed were accurately described by a smoke model derived for naturally-aspirated engine operation. Engine power, however, was significantly increased under supercharged operation. While operating with turbocharged air intake conditions, the relationships were strongly dependent upon the ratio of fuel injected before ignition to total fuel injected for the cycle. This dependency was also apparent for naturally-aspirated and supercharged air intake operation to the same relative degree. Smoke and engine performance models obtained using DF-2 diesel fuel were also accurate for use with DF-1 diesel fuel. The duration of ignition delay and thus the relative percentages of fuel injected before ignition (i.e. premixed fuel) and after combustion commences (i.e. unmixed, diffusion-burning fuel) are clearly significant in determining smoke level of diesel engines. Smoke level decreases as the percentage of fuel injected before ignition increases. A smoke factor (the ratio of equivalence ratio in the combustion chamber at initial ignition to overall equivalence ratio) has been formulated. This factor correctly describes smoke levels in diesel engines for the investigated changes in A/F, fuel injection timing, and engine speed using naturally-aspirated, supercharged, and turbocharged air intake conditions and both DF-1 and DF-2 diesel fuels.

by Walter Bryzik; Charles O. Smith
Army Tank-Automotive Res. and Devel. Command,
Propulsion Systems Div.; University of Nebraska
Rept. No. SAE-770718; 1977; 39p 25refs
Presented at Off-Highway Vehicle Meeting and Exhibition,
Milwaukee, 12-15 Sep 1977. Research sponsored by Army
Tank-Automotive Res. and Devel. Command; paper based on
doctoral dissertation, Univ. of Detroit by W. Bryzik.
Availability: SAE

HS-024 426

IMPACT TRAUMA OF THE HUMAN TEMPORAL BONE

A study was designed to examine temporal bone fracture produced in cadavers subjected to realistic automotive impact situations. Utilizing sled and piston impact configurations, frontal and parietal impacts were noted to produce ipsilateral and contralateral fractures of nine temporal bones in seven cadavers. The impact velocities varied between 18.1 mph and 25.0 mph. Using standard otologic microsurgical techniques, the temporal bones were dissected and numerous gross and microscopic injuries in middle-ear and inner-ear structures were found. It is concluded that extensive comminuted fracture of the human temporal bone is seen with realistic crash situations of low velocity, and that lateral impact which produces a longitudinal fracture with a posterior fossa comminution is associated with disruption of the cochlea and facial nerve, as well as of middle-ear structures. The classical transverse fracture of extensive skull trauma lies medial to these structures and does not involve the otologic contents of the human temporal bone. Skull fractures associated with lateral piston impact varied from those simply confined to the temporal bone to massive crash injury of the various bones of the ipsilateral hemi-skull. In all cases but one, laceration of brain and dura were present, accompanied by an experimentally-

produced cortical hemorrhage. The most massive skull and brain injuries occurred in the sled impact tests, depicting the disastrous consequences of unprotected lateral automotive impact.

by Lawrence W. Travis; Richard L. Stalnaker; John W. Melvin
Publ: Journal of Trauma v17 n10 p761-6 (Oct 1977)
1977; 12refs
Presented at 36th Annual Session of American Assoc. for The
Surgery of Trauma, Colorado Springs, 16-19 Sep 1976.
Availability: See publication

HS-024 427

STATISTICS OF ROAD TRAFFIC ACCIDENTS IN EUROPE (STATISTIQUES DES ACCIDENTS DE LA CIRCULATION ROUTIERE EN EUROPE) (STATISTIKA DOROZHNO-TRANSPORTNYKH PROISSHESTVIY V YEVROPE) 1976. VOL. 23

Basic statistical data on road traffic accidents and casualties in European countries, Canada, and the U.S. for 1970 (baseline period), 1975, and 1976 are tabulated. Summary tables give accident data for the years 1955, 1960, 1965, 1970, 1973, 1974, 1975, and 1976. Background statistics (motor vehicles in use (including mopeds), estimates of vehicle KM traveled, estimates of population and distribution by age group) are given for the years 1970, 1973, 1974, 1975, and 1976. Only those accidents involving personal injury are included. Data relate to accidents by nature of accident and surroundings, the influence of alcohol, and the number of persons killed or injured by category of road user and age group. Annexes provide definitions and bibliography.

Economic Commission for Europe, Geneva, Switzerland
Rept. No. UN-E/F/R.77.II.E.21; 1977; 116p 19refs
Text also in French and Russian.
Availability: United Nations, Sales Section, New York \$7.00

HS-024 428

ENERGY PROBLEMS AND URBAN AND SUBURBAN TRANSPORT

Short- and medium-term measures which may bring about energy (petroleum) savings in the urban transport sector without significant adverse effects on mobility or quality of service are analyzed. Measures which have been adopted in member countries of the Organisation for Economic Co-operation and Development, measures which have been considered for adoption but which were not implemented, and measures which are currently under study for future adoption are examined. The measures identified involve one or more of the following basic tactics: reduction in the number of trips, reduction in the amount of travel for certain trips, reduction of vehicle trips while maintaining transportation of people and goods, improvement in the petroleum efficiency of existing vehicles, use of other vehicles or modes which are more petroleum efficient, and use of a non-petroleum using mode. The assessment of the effectiveness of the energy-saving measures is very difficult in many cases because of a lack of scientific data regarding the effects of these measures. In spite of the limitations of the study, the complexity of the problems encountered, and the lack of comprehensive analyses upon which to draw, the information presented should be useful in clarifying certain basic issues regarding energy conservation in

road transportation and should provide a basis for future national and international research efforts in the field. Appended are a summary of national responses to the questionnaire, a list of group members, and a list of publications of the road research program.

Organisation for Economic Co-operation and Devel. (OECD), Road Res. Group on Energy Problems and Urban and Suburban Transport, 2, rue Andre-Pascal, 75775 Paris Cedex 16, France
Rept. No. OECD-40.211-1978; 1978; 65p 53refs
Published in French under the title: Problemes Energetiques et Transports Urbains et Suburbains.
Availability: Corporate author \$5.00

HS-024 429

THE DETERMINATION OF VEHICULAR COLD AND HOT OPERATING FRACTIONS FOR ESTIMATING HIGHWAY EMISSIONS

A study was undertaken to develop procedures by which cold- and hot-transient mode fractions for light-duty vehicles (automobiles) can be derived from existing transportation planning data. These fractions are required for calculating emission factors that are used in a variety of air quality analyses. At present, there are no procedures for calculating such fractions. The first part of the report describes the research in detail and provides a detailed procedure by which the cold and hot fractions can be calculated for any time of day for any set of urban traffic conditions. Seven urban areas (in Alabama and Massachusetts) varying in size from small to very large were analyzed to determine the extent to which the results can be generalized based on size. It is concluded that the profile of cold-start fractions by hour is similar for all urban areas analysed throughout the range of area size. However, large areas exhibit somewhat lower fractions during the early morning and late evening hours. The profile exhibits large hourly changes. The cold/hot mode fractions on an area-wide basis are greatly dependent on average trip length and city size, although the relationship is highly non-linear. The cold-mode fractions are inversely related to trip length and city size. The hot-transient mode fraction for catalytic equipment is directly related to trip length and city size. There are significant hourly changes. The cold/hot mode fractions will vary within a small portion of an urban area or a specific highway link dependent on the relative contribution of the trip purposes making up travel at a particular location. The results of the investigation have been generalized and quantified in such a way that it is not necessary to repeat the complete procedure each time new cold/hot mode estimates are needed. Part Two of the report is a workbook designed to be used alone. It documents methods that can be used by typical transportation or air quality agencies to determine the cold/hot fractions of travel for project or areawide analyses. Three levels of approach (simplified, abbreviated, and complete) are described. The simplified method is a generalization that is appropriate for areawide analyses or for analyses of highway projects in which the traffic mix by trip purpose is assumed to be similar to the areawide traffic mix in the areas studied in the investigation. The abbreviated method is appropriate for analyses of projects for which the traffic mix by trip purpose is assumed to be different from the areawide traffic mix in the areas studied, and the complete method is the procedure described in Part One of the report. It is time-consuming and not recommended unless the required resources are available and the trip-making characteristics of the area or the highway

project in question are known to be significantly different from those used in the development of the procedures.

by George W. Ellis; William T. Camps; Alton Treadway
Alabama Hwy. Dept., 11 S. Union St., Montgomery, Ala. 36130
DOT-FH-11-9207
1978; 97p 3refs
Availability: Federal Hwy. Administration, Office of Environmental Policy, Washington, D.C.

HS-024 430

AUTOMOBILE INSURANCE LOSSES, INJURY COVERAGES. CLAIM FREQUENCY RESULTS FOR 1974, 1975, AND 1976 MODELS

The frequencies of insurance claims for injuries to occupants of 1974, 1975, and 1976 model year passenger cars under medical payments and "no-fault" personal injury protection coverages are compared. Claim frequency results are presented for vehicle size classes and for body style subgroups (regular two-door models, regular four-door models, station wagons, and sports or specialty models) within each size class, as well as for individual vehicle series. Results are based on the experience of 1974 model year vehicles in the period Sep 1973 through Dec 1977, of 1975 model year vehicles from Sep 1974 through Dec 1977, and of 1976 model year vehicles from Sep 1975 through Dec 1977. The data were supplied by Allstate, Liberty Mutual, Nationwide, and State Farm insurers. The frequency of injury claims under both medical payments and personal injury protection coverages is strongly related to vehicle size; smaller vehicles have the highest and larger vehicles have the lowest injury claim frequencies. This is true for all of the model years and ages of cars. Regular two-door models consistently have higher injury claim frequencies than corresponding four-door models. Within each car size group, sports and specialty cars consistently have the highest injury claim frequencies; the only exception is the 1976 full-size group. There are substantial variations in the injury claim frequencies of different cars of the same size and body style. For example, among the 1974 model regular two-door compacts, the medical payments coverage relative claim frequencies range from a low of 90 for the Oldsmobile Omega to a high of 138 for the Ford Maverick. Variations in the injury claim frequencies of the cars within each model year are much more pronounced than the differences between different model years. Appended are the detailed injury claim frequency results (medical payments and personal injury protection coverages) for 1974, 1975, and 1976 models, specifications of injury coverages, sources and nature of data, definitions, and the confidence intervals for standardized claim frequency.

Highway Loss Data Inst., Watergate 600, Washington, D.C. 20037
Rept. No. HLDI-RR-I-76-2; 1978; 67p 3refs
See also HS-024 431 (1977 models).
Availability: Corporate author

HS-024 431

AUTOMOBILE INSURANCE LOSSES, INJURY COVERAGES. CLAIM FREQUENCY RESULTS FOR 1977 MODELS

The frequencies of insurance claims for injuries to occupants of 1977 model year passenger cars are compared by car size

group; body style subgroup, and individual series. Results are based on automobile insurance injury coverages and claims under "no-fault" personal injury protection and medical payments coverages during the calendar period Sep 1976 through Dec 1977. The data were supplied by Aetna Life and Casualty, Allstate, Liberty Mutual, Nationwide, and State Farm insurers. Under both types of injury coverages, cars with smaller wheelbases have higher injury claim frequencies than cars with larger wheelbases. In the compact and intermediate size groups, the injury claim frequencies are highest for specialty models, and are higher for regular two-door models than the corresponding regular four-door models. The injury claim frequencies vary considerably. The two-door Toyota Corolla and the Datsun B-210, the cars with the highest personal injury protection claim frequencies, each has more than twice the number of claims per insured vehicle year for injuries to occupants than the four-door Chevrolet Caprice Classic, the car with the lowest claim frequency. Appended are detailed injury claim frequency results (personal injury protection and medical payments coverages) for the 1977 models, specifications of injury coverages, sources and nature of data, definitions, confidence intervals for standardized claim frequency, and vehicle series designations.

Highway Loss Data Inst., Watergate 600, Washington, D.C. 20037
 Rept. No. HLDI-RR-I-77-1; 1978; 47p 3refs
 See also HS-024 430 (1974, 1975, and 1976 models).
 Availability: Corporate author

HS-024 432

TRANSPORTATION REGULATION AND PUBLIC POLICY

Transportation regulatory reform activities in the U.S. during the 1970's are traced, are compared with similar efforts of prior decades, and suggestions are made as to why the legislative proposals of recent years have met so far with minimal success. A critical examination of perceived problem areas is presented, and prescriptions for resolving both regulatory and public policy issues offered. The 1970's have witnessed a growing public awareness of and attention to regulatory activities, which has stimulated a process of critical examination. Independent as well as interrelated action occurred in Congress, at the Presidential level, in the agencies, and on the part of many consumer, environmental, business, and other organizations and interests. Certain fundamental regulatory issues which persistently reemerge as perceived problem areas are regulatory criteria for entry, rate structures and levels, carrier acquisitions and mergers, service abandonments, operating restrictions, and adequacy of revenue levels to satisfy capital needs. The extent to which regulatory issues have followed beaten paths is striking. Excluding recent concerns over energy shortages and environmental degradation, it would be difficult to identify any major regulatory issue discussed in contemporary studies that was not previously investigated in some depth. Past studies of transportation regulation generally have failed to provide information critical to resolving questions that are raised continually. This failure is largely attributable to an absence of economic impact analyses, an absence of social benefit-cost analyses, an absence of a hierarchical classification of regulatory issues, and a failure to consider alternative means of achieving nontransportation public policy objectives. If transportation is to be regulated in a way that is appropriate to the times and is sensitive to new pressures, more precise determinations must be made about whether the cur-

rent regulatory framework is truly socially beneficial, incremental, or grossly counterproductive in achieving statutory enunciated objectives. Moreover, answers must be provided to tell which constituencies (consumers, businesses, labor groups, suppliers, and regions) will gain or lose, and by how much, from alternative types of control. There also should be increased understanding of how well regulation does the job compared to other political tools. Regulatory policy decisions should be made in the context of open public disclosure and debate of objectives, merits, and social costs.

by Leigh B. Boske; John W. Fuller
 Publ: Traffic Quarterly v32 n4 p493-510 (Oct 1978)
 1978; 41refs
 Availability: See publication

HS-024 433

THE LAW AND BICYCLE SAFETY

Several studies were undertaken to measure bicyclists' law observance and law knowledge in New York State and to suggest safety improvement strategies. Two field studies were conducted, the first to observe the patterns of traffic law observance through intersections and how the age of the bicyclist related to law violations, at 15 intersections in Buffalo and suburbs; the second study to observe traffic law observance related to intersection variables (business or residential district, 3-way or 4-way intersection, and stop-sign or traffic signal control) and to compare law observance of bicyclists and car drivers, at 24 intersections. The two experiments showed a distinct pattern of law violation among bicyclists. Bicyclists were judged to break many more laws than motorists; these law violations decreased sharply with age. Most law violations were failing to signal, failing to stop, and driving on the wrong side of the road. Another study involved administration of The Bicycle Law Knowledge Test to groups of children, students, parents' organizations, and so on, in citizens' groups in Buffalo and suburbs. Almost all respondents knew that the law applies to bicyclists, but they did not know well enough what the law requires. Even worse, the evidence showed that more people disobey the law than are ignorant of it. Law knowledge was found to increase with age, and parallel law observance, at least until the mid 20's. It was found that adults from 23 years of age or older show a decrease in law knowledge. The lack of law observance among bicyclists is not just a reflection of a lawless society; automobile drivers break fewer than one-third as many laws, when age differences are taken into account. Society must either accept this current level of violation of the law or reduce it by increasing bicycle law knowledge through teaching and instruction, increasing compliance by enforcement as well as example, or changing the law so that bicyclists are no longer in violation. Society must make the basic decision of whether it prefers the present unpredictable bicycling with the "freedom" to ignore the law, or a more controlled and potentially safer bicycling public.

by Colin G. Drury
 Publ: Traffic Quarterly v32 n4 p599-620 (Oct 1978)
 1978; 12refs
 Sponsored in part by Inst. for Public Policy Alternatives.
 Availability: See publication

HS-024 434

SERVING TRANSPORTATION NEEDS OF THE ELDERLY: AN OVERVIEW

The underlying reasons why the elderly in the U.S. are faced with special problems of immobility, recent and projected changes in their participation in the labor force, and the effects of increases in the average life span are reviewed, and the various Federal programs to meet the special needs of the elderly for transportation services are summarized. The private car is now the dominant mode of personal travel in the U.S., and employment opportunities, residential areas, and recreational, educational, and cultural activities have become increasingly dispersed. Because they generally have a fixed and low level of income or have physical limitations that make driving difficult or impossible, only 12 million of the nation's 23.4 million persons 65 or more years of age in 1976 had driver's licenses (54.3%). Even among those who do drive cars, their yearly driving mileage starts to decrease around age 55, and, as they grow older, they tend to cut down on the number of days on which they drive and drive less during rush hours, at night, and in winter. The superior safety record of drivers 65 through 74 is related to this reduction in yearly travel. However, for every mile they are on the highway, their probability of involvement in accidents is about twice as great as for middle-age drivers. Other disadvantages for the elderly in using their own cars are the costs of operation and maintenance. There is considerable evidence that the declining participation of the elderly in the labor force is due to the continuing shift of employment locations away from areas served by public transportation, and the curtailment or abandonment of transit service in many urban areas. The change in the mandatory retirement age permits the elderly to remain in the labor force beyond 65, and will result in reducing the cost burden of tax-supported social services for the elderly and the funding needs of the Social Security program. However, improved public transportation services for the elderly, as well as for the physically handicapped, will be necessary. The Urban Mass Transportation Act of 1964 specified that special efforts be made in the planning and design of transit facilities and services receiving Federal funding assistance to meet the special needs of the elderly and the handicapped. A number of innovative projects designed specifically to meet the mobility needs of these groups have been undertaken through Urban Mass Transportation Administration demonstration grants. The new approaches in vehicle types, coordination with existing transit and taxicab operations, dispatching methods, and billing systems for sharing of costs used in such areas as Portland, Oreg., Montgomery, Ala., Valley Transit District, Conn., Albuquerque, N. Mex., Stanford, Calif., Cleveland, Ohio, and Syracuse, N.Y. are described.

by Stanford I. Polonsky, Jr.
 Publ: Traffic Quarterly v32 n4 p621-33 (Oct 1978)
 1978; 11refs
 Availability: See publication

HS-024 435

TURNING NIGHT INTO DAY [NEW HALOGEN HEADLAMPS]

The recent doubling of the maximum allowable light intensity for car and truck headlamp high beams to 150,000 candlepower per vehicle was made possible by the development of a new type of sealed-beam lamp that produces an intense white light at no more current draw than ordinary headlights.

The light from a set of the new halogen headlamps will appear whiter and brighter, and nighttime seeing distance will be increased markedly, from 25% to 50%, according to lamp manufacturers. Both the standard headlight and the halogen type are classed as incandescent lamps. In the case of the standard sealed-beam unit, the entire headlight is the bulb. However, the halogen lamp's tungsten filament is surrounded by a tiny jellybean-sized inner bulb made of quartz (to resist heat), not present in the standard lamp. This inner bulb contains, in addition to the normal fill of inert gas, a small amount of either iodine or bromine (halogens). Filament evaporation at very high operating temperatures occurs in the halogen lamp as it does in a standard lamp; but as the tungsten evaporates, it combines with the halogen material and subsequently is redeposited back on the filament. No blackening of the bulb occurs as when the standard bulb's tungsten evaporates and subsequently condenses on the inner wall of the bulb. Also, the presence of halogen allows the filament to burn much hotter and brighter than that of a standard lamp, without boiling away in a few minutes. Headlamp manufacturers are now gearing up for production of halogen-sealed beams to meet the new candlepower limit. Manufacturers say the new lights will be more expensive than standard units, perhaps as much as several times more. Whatever the cost, the development and legalization of higher-power sealed-beam headlights will increase safety during nighttime driving.

by Dave Ritchie
 Publ: Traffic Safety v78 n10 p8-9, 28 (Oct 1978)
 1978
 Reprinted from Commercial Car Journal, Jul 1978.
 Availability: See publication

HS-024 436

THE MANAGEMENT OF SPEED [ENFORCEMENT OF SPEED LIMIT LAWS]

The question of how to increase the ability of the individual patrolman to control the speed of vehicles in the traffic stream is considered. The implications of the present enforcement policy, which assumes that the capability to detect and apprehend violators will ultimately affect the violator's decision to speed, are analyzed. The overriding implication of this assumption is that no attempt is made to influence the violator directly prior to the making of that decision. It is only after the decision to speed is made (and the violation committed) that enforcement actions come into play. In translating this concept into practice, the most appropriate action to be taken by an individual policeman is to patrol in such a manner that detection by speeders is difficult. This action includes the use of unmarked patrol cars, flip-flop operations, and the use of aircraft for remote detection. The net effect of this mode of operation is to create an environment in which motorists who desire to speed feel free to do so, because the police are not visible. There is no doubt that this policy is successful in detecting and apprehending speeders, but serious questions must be raised regarding the ability of this enforcement philosophy to control vehicle speeds. The critical variable in any enforcement effort is the subjective probability of being apprehended. A research effort was undertaken by the Texas Transportation Inst. to develop and evaluate a strategy to maximize the effect of the individual patrol vehicle on traffic speeds. The establishment of speed-limit compliance behavior was accomplished by deploying high visibility (i.e. easy for the motorist to detect) patrols over a selected segment of roadway for 6 weeks. The police unit was deployed along a high-volume

roadway to maximize exposure, was used during the same time period each day (rush hours), remained stationary (maximizing effect), was in a random location from day to day, and was in a highly visible location. The principal objective of continuous reinforcement was to train motorists to believe that a patrol vehicle would be located somewhere along the particular road every day, while keeping them uncertain of its exact location. Analysis of speed data indicated that this strategy decreased both average speed and speed variability over time, that the strategy had an effect up to 14 miles (two to three times greater than standard scheme), that vehicles with citizen band radios (CB's) travel faster than vehicles without, that there is no relation between number of citations issued and average speed for a particular day, and that there is no correlation between CB reports of patrol presence and average traffic speed.

by Mark Lee Edwards; Robert Quinn Brackett
 Publ: Traffic Safety v78 n10 p18-20, 28-30 (Oct 1978)
 1978
 Availability: See publication

HS-024 437

EVALUATION OF BENEFITS OF THE INDIANAPOLIS INNERBELT SYSTEMS [FREEWAY]. FINAL REPORT

A research effort was undertaken to identify and evaluate the benefits of travel time savings, accident savings, and vehicle operating cost savings attributable to the Indianapolis Innerbelt Freeway System over the period 20 Nov 1976 through 19 Nov 1977. An underlying assumption used throughout this investigation was that vehicles now utilizing the Innerbelt Freeway System would, in the absence of the System, have to utilize the surface arterial streets. This assumption was then modified to account for the induced traffic component of the Innerbelt average daily traffic. The benefits that accrued to the road users due to the development and construction of the Innerbelt were estimated as the additional travel time, accidents, and vehicle operating costs that would have occurred if the current Innerbelt trips were made on the arterial streets. Travel time, accident rate, and operating cost comparisons were made between Innerbelt routes I-65 and I-70, and corresponding arterial routes, U.S. 52 and U.S. 40. It was found that the travel time savings attributable to the Innerbelt Freeway System amounted to approximately 9.7 million hours for the year studied. It was estimated that due to the construction of the Innerbelt, at least 2675 accidents were eliminated, of which 16 would have been fatal, 854 would have involved personal injury, and 1805 would have involved property damage only. The savings in operating costs is estimated at \$6,974,000. Appended are sample freeway volume calculations, a table of peak period and off-peak period travel times, and sample operating cost calculations.

by Charles Dulic
 Purdue Univ., Joint Hwy. Res. Proj., West Lafayette, Ind.
 Rept. No. JHRP-78-17; 1978; 73p 18refs
 Prepared in cooperation with Indiana State Hwy. Commission.
 Availability: Corporate author

HS-024 438

INVESTIGATION OF HIGHWAY LIGHTING [INTERSTATE]

A summary and analysis is presented of all major problems that have been encountered in tower lighting installations at 10 locations on the Interstate System for which the State of Iowa is responsible (87 tower lighting units with a total of 602 luminaires). All tower lighting units are equipped with luminaire lowering devices to facilitate maintenance problem areas on the lowering devices requiring maintenance attention were identified. First, drag brakes were added to winches for 25 towers at four locations. The brakes were furnished by the manufacturer of the towers and the winches, to improve the self-sustaining characteristic of the winches. Second, counterweight guide cables became twisted about the lift cables in two towers at one location and had to be repaired. Preventive maintenance consisted of inspection and tightening of eye-bolt nuts on all tower lowering devices. Third, at two locations, support cables were adjusted for several lowering devices to level the support ring and prevent movement of the ring when the luminaire was raised position. This movement injured the electric cable of one lowering device, requiring replacement of the cable. Periodic inspection should prevent a recurrence. Fourth, at one location, much difficulty is experienced in training personnel to load cable onto the winch drum. This appears to be aggravated by the curvature in the tower shaft caused by uneven heating of the sun. Present design practice requires the axis of the drum to be oriented east-west to minimize this effect. Fifth, retainer shields to prevent lift cables from leaving the sheaves did not function as required at one location. Retainer shields have been redesigned for new lowering devices and have proved satisfactory to date. Sixth, other mechanical problems include physical damage to connecting cables, cracks and abrasions, due to handling, and cable ends becoming detached. The number of connecting cable failures has been reduced in present designs and strain-relief type connectors specified. Any increase in handhole size on the shafts would be beneficial. Electrical problems are centered upon operation of the high-pressure sodium ballast lamps (premature failure); new designs should offer more consistent service. Single locations have had problems with premature failures of photoelectric control, rodents, or site lighting. The maintenance problems are not considered excessive.

by Floyd W. Christofferson
 Iowa Dept. of Transportation, Ames, Iowa 50010
 Publ: Maintenance Trouble Shooter 78-1
 1978; 5p
 Reprinted from original report. Cover title: On-Site Roadway Highway Lighting.
 Availability: Federal Hwy. Administration, Washington, D.C. 20590

HS-024 439

AMBULANCE SERVICES: A SELECTED BIBLIOGRAPHY

A list of references covering the period 1965 to mid-1978 on the subject of ambulance services is presented. The o

tion criterion was that the literature deal with ambulance operations.

by Joseph Lee Cook, comp.
Texas Christian Univ., Mary Couets Burnett Library, Tex.
Rept. No. CPL-Exch-Bibl-1470; 1978; 16p 163refs
Availability: Council of Planning Librarians, P.O. Box 229,
Monticello, Ill. 61856

HS-024 440

DECISION SIGHT DISTANCE FOR HIGHWAY DESIGN AND TRAFFIC CONTROL REQUIREMENTS. FINAL REPORT

Decision sight distance (DSD) has been defined as the distance at which drivers can detect a hazard or signal in a cluttered roadway environment, recognize it or its threat potential, select the appropriate speed and path, and perform the required action safely and efficiently. A research effort was devised and undertaken to relate this concept to specific road types, design speeds, traffic operating conditions, geometric features, and driver attributes. The first phase consisted of critically evaluating and synthesizing relevant literature pertaining to DSD and deriving values for highway design. A hazard avoidance process model was identified as a basis for quantifying DSD. The process includes the three elements of information processing, detection, recognition and decision-making, and the initial response and vehicle maneuver. Preliminary DSD values (divided into pre-maneuver and maneuver phases) based on the estimated times for the various elements of the model as reported in the literature were developed. In the second phase, a validation study of the derived DSD values was undertaken in which an instrumented vehicle was driven by 19 subjects through eight typical highway situations. In general, the results of the field study supported the derived DSD values, with some modifications, and confirmed that DSD is operationally valid. The use of DSD is recommended for applications in highway design (either for new facilities or reconstruction of below-standard facilities), particularly in those locations characterized by conditions that create the potential need for drivers to depart from simple steering and speed control maneuvers performed to follow the road, and in those locations where drivers could experience problems in handling information (e.g. interchanges, intersections, toll plazas, pavement width reductions). The second suggested application is for traffic control techniques at hazardous locations, specifically the determination of the need for and location of advance warning signs. The site diagrams and discussions are appended.

by Hugh W. McGee; Wilson Moore, Jr.; Beverly G. Knapp;
James H. Sanders
BioTechnology, Inc., 3027 Rosemary Lane, Falls Church, Va.
22042
DOT-FH-11-9278
Rept. No. FHWA-RD-78-78; 1978; 74p 85refs
Rept. for Jan 1977-Feb 1978.
Availability: NTIS

HS-024 441

ELIMINATING AUTOMOBILE OCCUPANT COMPARTMENT PENETRATION IN MODERATE

SPEED TRUCK REAR UNDERRIDE CRASHES: A CRASH TEST PROGRAM

A program is described which demonstrates the feasibility of significantly improving the performance of underride guards on trucks with little or no increase in guard weight. In Jun 1971, the National Hwy. Traffic Safety Administration (NHTSA) cancelled its rulemaking action regarding upgraded Federal requirements for underride protection on the grounds that the safety benefits it would achieve would not be commensurate with the cost of implementation. Most of the implementation costs estimated by NHTSA were related to the increase in guard weight which it thought was needed to meet the proposed requirements. The specific vehicle chosen for modification was a Fruehauf 40-ft sliding tandem axle, van-style semitrailer. Sliding axles, which can be set at various fore and aft positions, are a common feature on semitrailers because they enable distribution of the load between the tractor and semitrailer axles. Fruehauf trailers were chosen because this firm is currently the largest trailer manufacturer in the U.S. However, it is likely that guard improvements developed in this program are suitable for application to a variety of different truck and trailer makes and models. The principal objective in the design of the underride guards was to develop devices which would prevent penetration of the occupant compartments of automobiles in impacts into the rears of semitrailers. In the first phase of the program, underride guard performance criteria were established and two underride guards were designed and fabricated to meet these criteria. In the second phase, semitrailers equipped with these prototype guards and with standard guards supplied by Fruehauf were impacted by automobiles at moderate speeds to compare guard performance. Details and photographs of the design and testing are provided. The Insurance Inst. for Hwy. Safety prototype devices used in this program were one of many possible approaches to the rear underride problem. Other devices may be developed which are capable of preventing passenger compartment penetration in impacts over an even broader range of speed differentials and crash configurations.

by Loren A. Zaremba; Jackson Wong; Charles Moffatt
Insurance Inst. for Hwy. Safety, Washington, D.C.; West
Virginia Univ., Dept. of Mechanical Engineering and
Mechanics, Morgantown, W. Va.
1977; 66p 17refs
Availability: Corporate author

HS-024 442

SEEMINGLY UNRELATED REGRESSION AND THE DEMAND FOR AUTOMOBILES OF DIFFERENT SIZES, 1965-75: A DISAGGREGATE APPROACH

A multiequation model is developed to explain the U.S. demand for automobiles of different sizes during the period 1965-1975. The automobile market is divided into segments according to manufacturer's classification (subcompact, compact, intermediate, full-size, and luxury). The model fitted is linear using per capita data. The concept of "seemingly unrelated regression equations" is used to estimate the parameters of the five-equation model. The objectives of the study are to develop a useful methodology that can be used to build a disaggregate model of the automobile market, to use the five-equation model to determine key variables in the demand for different-sized cars, to estimate the price elasticity of demand for automobiles of different sizes, and to interpret the model as to its basic implications for future demand. In interpreting

the model it was obvious that disposable income is the variable of greatest impact, since consumer purchasing power is the primary determinant of expenditures on durable goods. Sales price is a powerful variable, which is in contrast to many previous studies; however, auto stock was not found significant in all equations (higher degree of aggregation in previous studies possibly dampened effect of price while magnifying that of stock). Sales price appears to have a lesser import on subcompact and luxury cars than on compact, intermediate, and full-size automobiles. On the other hand, income seems to be a relatively more important factor in the subcompact and luxury markets. While it is certainly possible that income influences luxury demand more than sales price, this effect is not as apparent for subcompacts, possibly because subcompact cars became popular as a second car due to increasing standards of living and their economy. The model supports the proposition that income, not sales price or gasoline economy, caused the growth (or at least the onset) of the small-car market. An analysis of the compact-, intermediate- and full-size-car equations shows that sales price is a prime determinant in their purchase. The model also suggests that sales of intermediate- and full-size cars are affected strongly in an adverse manner by the price of gasoline and supports the claim that poor fuel economy has been a prime reason for these cars losing sales in recent years. As expected, however, the model indicates that higher gas prices caused increased demand for subcompact and compact cars. In addition, the gasoline shortage increased the demand for subcompacts, but decreased the demand for all other cars. Subcompact demand is seen to be inelastic, with that of compact, intermediate, and full-sized cars being slightly elastic. Automobiles are deemed necessities, but larger ones must be regarded as a greater luxury item than smaller ones. This elasticity pattern seems to be supported by the fact that the smaller cars, especially subcompacts, have increased in price more (as a percentage) than larger ones over the time period of the study. The model suggests that unless real disposable income increases at rates equal to prerecessionary levels, long-run demand could stagnate at less than pre-1974 levels, even under favorable assumptions about energy and car prices. A redistribution of demand to smaller cars will be inevitable if the energy crisis recurs. This redistribution could take time because of habit - Americans like to drive large cars.

by Rodney L. Carlson

Publ: Journal of Business of the University of Chicago v51 n2 p243-62 (Apr 1978)

1978; 17refs

Availability: See publication

HS-024 443

ASPECTS OF CAR DESIGN AND CHILD RESTRAINT SYSTEMS

When children travel in cars they are riding in vehicles designed to seat adults. Interior dimensions, seating, and safety equipment provided are all chosen with the adult in mind. The differences in injury pattern between children and adults are considered, and the results of analyses of car accidents in Great Britain involving children are presented. The particular requirements for protecting children against injury in car accidents are discussed, and the performance of current British child restraint systems is reviewed. The data indicate that children are injured less often in car accidents than adults and are safer in the rear seats than in the front ones. The most frequent injuries to children and adults are those to the head.

Child restraint systems need to be designed to suit the child's anatomy, and need to be adjusted correctly to bear against the strong parts of the body. Accident investigations including a study of serious accidents, indicate that safety restraints to current British standards are effective in reducing the number and severity of injuries to child car occupants. There were only five children killed while using approved child restraints in Great Britain in the period 1972 to 1974 (in comparison with a total of 2260 children under the age of 15 who were killed or seriously injured in cars in 1974 in Britain). While injury to child vehicle occupants is important, injuries received by children as pedestrians are a much more serious problem. In 1974 about 9300 child pedestrians were killed or seriously injured in Britain.

by R. W. Lowne

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Rept. No. PB-277 033; TRRL-SR-296; 1977; 22p 17refs

Presented at Conference on Children, the Environment and Accidents, Univ. of Newcastle-upon-Tyne, England, 24-25 Sep 1976.

Availability: NTIS

HS-024 444

THE DRUNKEN DRIVER: A PSYCHOSOCIAL STUDY

A self-administered questionnaire was used to compare selected psychosocial variables of 306 convicted male drunk drivers with those of 294 alcoholics and 253 controls. The results of the study are presented in three sections: a comparison of the three groups for variables related to differences in drinking characteristics, a comparison for variables related to differences in psychosocial characteristics (reasons for drinking, effects of drinking, stress, coping with tension and depression, neuroticism, self-esteem, self-control, responsibility, paranoid thinking, depression, aggression), and an examination of whether the drunk driver sample is made up of two discrete groups (social drinkers, alcoholics). The drunk driver group fell between the other groups on many parameters but resembled the alcoholic group on many others. While over 68% of the drunk drivers appeared to be alcoholics, in general, they showed significantly less psychosocial incapacity than the alcoholic comparison group. The differences between the alcoholic and presumed non-alcoholic drunk drivers were not sufficient to dichotomize clearly the drunk driver group. When compared to the control group, the drunk drivers were more aggressive, more depressed, and had less self-esteem, less responsibility, and less self-control. Factors such as low responsibility and impaired self-control imply a quality of impulsivity that may explain the difficulty in finding solutions to the drunken driving problem. The data indicate that most drunk drivers, whether or not they are alcoholics, usually have distinctive psychosocial and drinking problems. Most would undoubtedly benefit from rehabilitative programs. One problem in establishing rehabilitation programs for this group is that drunken driving is not a definable illness; it is an event that must first occur before any cure can be initiated. Another problem is the sheer number of drunk drivers and how very few can be apprehended. There is reason to believe that apprehension and conviction of drunk drivers, as presently implemented, is a waste of time, both in terms of those apprehended, and because of the many undeterred drunk drivers not apprehended at all. The importance of drunk driving arrests should not be overlooked, however. Many alcoholics are now successfully treated following a drunk driving arrest. Methods to deter drivers before they become drunk drivers are essential.

tial. Attempts to educate or appeal to the driving public have not been particularly successful, nor have strategies that rely on stringent penalties. A reduction in alcohol consumption may be attempted through banning advertising, reducing the hours during which alcohol can be sold, and increasing taxation.

by Melvin L. Selzer; Eugenia Barton
NIAAA-AA00495-02

Publ: Drug and Alcohol Dependence v2 n4 p239-53 (Jul 1977)
1977; 22refs

Availability: See publication

HS-024 445

AN EVALUATION OF THE INCREASE IN TRAFFIC FATALITIES IN VIRGINIA IN 1977

Since the oil embargo of 1973, the number of fatal traffic accidents and fatalities in Virginia had been relatively stable from year to year until Sep 1977 when fatalities began to occur at an alarming rate. By the end of 1977, the total number of traffic fatalities had increased dramatically from the 1976 total. To determine the reason(s) for this increase, fatal traffic accidents in Virginia in 1976 and 1977 were examined by using data stored in the Fatal Accident Reporting System (FARS). Descriptors of the fatal accidents such as driver demographics, human factors, vehicle characteristics, and road conditions were examined using the FARS; the data obtained were grouped in three categories: accident, vehicle/driver, and person. For 1976, 808 accidents involving 1274 vehicles and 2049 persons were analyzed for 1977. Classification of trafficway was found to differ significantly for 1976 and 1977 fatal accidents, with an increase in interstate and other U.S. route accidents in 1977. Vehicle-related factors were similar for 1976 and 1977 fatal accidents, except for an increase in 1977 in the involvement of vehicles with one or two occupants, as opposed to three or more occupants. For vehicles involved in fatal accidents, there were some changes in the distributions of vehicle weight from 1976 to 1977; vehicles involved in 1977 crashes appeared to be slightly heavier. In 1977, there were fewer drivers who were considered impaired at the time of the accident (i.e. asleep, inattentive, etc.) and a smaller percentage who had been involved in previous traffic accidents or who had had previous traffic convictions. Persons in the driver's seat of the vehicles involved in fatal crashes showed a decrease in seat belt usage in 1977. There was no indication that a change in Virginia's highway safety program is warranted, although there continues to be a need for promoting seat belt usage. Because of difficulties with the data output, problems encountered in accessing the FARS system, and the expense involved, it is concluded that the use of FARS does not seem to be the best method of evaluating characteristics of Virginia traffic fatalities and such use is not recommended.

by Deborah Mitchell; Cheryl Lynn
Virginia Hwy. and Transportation Res. Council,
Charlottesville, Va.
Rept. No. VHTRC-79-R10; 1978; 24p 4refs
Sponsored by Virginia Dept. of Transportation Safety.
Availability: Corporate author

HS-024 446

THE EFFECTIVENESS OF SEAT BELTS IN REDUCING INJURIES TO CAR OCCUPANTS [ENGLAND]

Detailed investigation of 1126 accidents in England involving 1664 vehicles and 2879 occupants, representative of all injury severities, was undertaken between 1974 and 1976 in order to compare the injuries sustained by unbelted and belted car occupants. The survey showed that seat belt wearers sustained fewer and less serious injuries than non-wearers. Seat belts prevented or reduced the severity of injury by restraining the wearer and reducing the likelihood of coming into violent contact with the interior of the passenger compartment and by preventing ejection from the vehicle. The use of seat belts was responsible for an almost 50% reduction from the expected level in all but the minor injuries. Where seat belts prevented the more serious injuries, the crashes were no less severe and lesser injuries often still occurred. Of the belted occupants, 42% escaped injury altogether compared to 28% of the unbelted ones. As with unbelted occupants, the head was the most commonly injured region of the body of seat belt users. Therefore, protection for the head needs most consideration when designing an overall system for occupant restraint and protection. For the belted occupants, injuries greater than minor (Abbreviated Injury Scale 2-6) to the shoulder, chest, and abdomen were caused most frequently by contact with the vehicle interior; for minor injuries, direct seat belt loading was the most frequent cause. No cases were identified where the occupant would have been safer not wearing a seat belt. There was no evidence that belt wearers were at any greater risk than non-wearers in the rare fire and drowning incidents. Comparisons between automatic and static seat belts showed that both were equally good at reducing injuries, but there was an indication that the former were more likely to be worn. No cases of failure affecting the performance of the seat belt were identified. A seat belt usage rate of 100% would give an estimated further saving of over 12,000 fatalities and serious injuries per year (or 9000 at 85% usage).

by C. A. Hobbs
Transport and Road Res. Lab., Accident Investigation Div.,
Crowthorne, Berks., England
Rept. No. TRRL-LR-811; 1978; 23p 11refs
Availability: Corporate author

HS-024 447

INTERNATIONAL DRIVERS' BEHAVIOUR RESEARCH ASSOCIATION CROSS-NATIONAL ATTITUDES AND OPINIONS SURVEY: REPORT OF UK FINDINGS

As part of an international survey of drivers' attitudes toward road safety, 1400 drivers in the U.K. were sent a questionnaire to elicit their opinions. The use of Driving and Vehicle Licence Centre records to sample drivers, coupled with two reminder letters, led to a high response rate (81%) at a relatively low cost. The human factor was identified by the respondents as the most important cause of road accidents, with inattention rated as the most important causative human failing. Although about half the sample thought that more government money should be spent on training and testing drivers, "inexperience" received a low rating as a causal factor in road accidents. Attitudes toward speed limits showed a widespread social acceptance of exceeding the speed limit

(only 18% of respondents claimed that they always obeyed the speed limit, only one respondent believed that other drivers always obeyed the speed limit). Respondents perceived most other drivers as following too closely (for reasons of impatience or lack of awareness of stopping distances). Overtaking was rated as a more dangerous driving action than turning right or entering a motorway. The contribution which the police do and should make to road safety emphasized police presence as the main safety aid, with enforcement of drinking and speeding laws next. There was widespread recognition of the importance of alcohol as a causal factor in injury accidents. The claimed rate of seat belt usage probably was overstated (always 24%, most of time 23%). From roadside observations, seat belt usage is about 30% during daylight hours. More than 90% of the replies rated seat belts as very or fairly effective in the event of an accident. Despite this, there was a majority of 6 to 4 against compulsory seat belt use. Previous accident history did not affect attitudes about compulsory belt wearing. Perception of "near misses" in normal driving (very often 4%, fairly often 25%, rarely 67%, never 3%) did not relate to the reported injury accident record. Respondents had a generally pessimistic view of accident trends, most believing that their risk of being injured will be higher in the future than it is now. Road accidents were seen as the most threatening physical danger by a majority of the respondents. A copy of the questionnaire, with responses, is appended.

by D. G. Jenkins
Transport and Road Res. Lab., Road User Characteristics
Div., Crowthorne, Berks., England
Rept. No. TRRL-SR-403; 1978; 16p 3refs
Availability: Corporate author

HS-024 448

THE EFFECT OF MOTORWAY SIGNALS ON TRAFFIC SPEED [ENGLAND]

The effect on vehicle speed of advisory speed indications on highway signs has been measured at two sites on the M1 motorway in England. On an urban section of the motorway at Scratchwood in North London, measurements were made of vehicle speeds before and after a set (3) of signals were mounted overhead. The signals were set to show an advisory speed of 50 mph. Control measurements were also made with the signals switched off. The average speed of light vehicles in the right-hand lane (fast lane) was reduced from about 78 mph to 71 mph (9% decrease); in the center lane, from about 69 mph to 63 mph (7 1/2% decrease); and in the left-hand lane (slow lane), from about 57 mph to 55 mph (4% decrease). Similar measurements were made on a rural section of the motorway at Newport Pagnell where single speed signals were mounted on posts in the median strips. The average speed of light vehicles in the right-hand lane was reduced from about 77 mph to 69 1/2 mph (9 1/2% decrease); in the center lane, from about 68 mph to 63 mph (7% decrease); and in the left-hand lane, from about 55 mph to 52 mph (5% decrease). Speed reductions for light vehicles on both sections were similar. For heavy vehicles, only the speed reductions (2% to 4%) in the slow lanes at both trial sites were significant.

by C. J. Lines
Transport and Road Res. Lab., Hwy. Traffic Div.,
Crowthorne, Berks., England
Rept. No. TRRL-SR-363; 1978; 20p
Availability: Corporate author

HS-024 449

TRAFFIC INCIDENTS ON THE M1 MOTORWAY IN HERTFORDSHIRE [ENGLAND]

An on-the-spot (from police patrol cars) study of traffic accidents on 21 km of the M1 motorway in Hertfordshire (England) covering a period of 29 days during Jul, Aug, and Sep 1976 confined to weekend peak traffic periods, proved very effective in identifying the main characteristics of highway accidents and some of the problems associated with traffic control. In addition, it was possible to determine some of the principal factors causing accidents and to assess their effects on traffic behavior. Data relating to incident detection times, police response, and roadway clearance were also obtained. The main disadvantage of this on-the-spot technique is the time needed to obtain a reasonably large data sample. The present study involved 180 hours of observation during which time 75 accidents were recorded. Problems on this section of the motorway arose from the combined effects of high traffic flows, capacity constraints (inadequate roadway width gradients), poor design features, competitive driving conditions, and an easily distracted motoring public. The consequences were recurrent congestion, frequent tailgating collisions, and traffic delays, all of which occurred despite the presence of an alert and efficient police force, emergency signals, street lighting, recent resurfacing, and a driver population with a high proportion of regular users. While it is unlikely that a complete solution to these problems would be found, improvements should result from work on the following: traffic management measures to increase the throughput on the two-lane section (although in the long term the most effective solution probably would be to provide more lanes); the early detection of incidents, including turbulence; and the improvement of the impact of the existing signaling system.

by D. Owens
Transport and Road Res. Lab., Hwy. Traffic Div.,
Crowthorne, Berks., England
Rept. No. TRRL-SR-390; 1978; 16p
Availability: Corporate author

HS-024 450

HIGHWAY VEHICLE SYSTEMS CONTRACTORS COORDINATION MEETING (13TH) SUMMARY REPORT. OCT 4, 5, 6, 1977, DEARBORN, MICHIGAN

Summarized are presentations and discussions at the 13th Contractors' Coordination Meeting held by the Dept. of Energy (DOE) Office of Hwy. Vehicle Systems to stimulate and promote the maximum rate of technical progress toward U.S. energy conservation objectives in highway vehicle systems. At these meetings, DOE contractors, staff consultants, prospective contractors, and selected guests discuss the trends, requirements, the status of current programs, and the plans for future programs. In addition, the meetings provide an opportunity for interaction among the participants on problem areas of mutual interest. Over 400 people from the government, industry, and technical community attended this meeting, representing 169 organizations. Presentation summaries are grouped under the following broad subject areas: orientation and overview presentations by DOE, the National Aeronautics and Space Administration (NASA), and the Jet Propulsion Laboratory (JPL); Vehicle Systems Prog.; Gas Turbine Engine Development Prog.; Gas Turbine Technology Programs; Stirling Engine Prog.; and Alternative Fuels Utilization Prog. Appended are

June 29, 1979

HS-024 453

list of attendees/organizations, and a list of the general context of each of the displays provided by various organizations.

Department of Energy, Div. of Transportation Energy Conservation, Washington, D.C. 20545
Rept. No. DOE-CONF-771037; DOE-UC-96; 1978; 434p refs
Includes HS-024 451--HS-024 488.
Availability: NTIS \$14.50 printed copy, \$3.00 microfiche

HS-024 451

REVIEW OF JPL [JET PROPULSION LAB.] AUTOMOTIVE TECHNOLOGY STATUS AND PROJECTIONS (ATSP) PROJECT

The general objective of the Jet Propulsion Lab.'s Automotive Technology Status and Projections (ATSP) Proj. is to make a continuing assessment of current automotive technology development programs and of prospects for new concepts. The study embraces alternative engines, advanced powertrain components, and related energy-conserving vehicle modifications which could be implemented by the end of this century. Vehicle-level projections of the fuel economy and emissions potential of alternative power systems are key elements in this assessment. A major product of this work is a series of annual technology assessment reports on progress made in the prior year toward meeting the Dept. of Energy's objectives in ongoing automotive technology development. Another product is a series of technical task summary (TTS) documents summarizing the current status of alternate automotive power systems technology. The Uniform Charge Otto engine was selected as the baseline power system for comparing alternative heat engine systems. Both conventional reciprocating and rotary configurations are being considered, with emphasis on the three-way catalyst approach for emissions control. Since the Brayton and Stirling engines were found to be promising alternatives in an earlier study, considerable attention has been devoted to reassessing their potential in light of advancements in engine development and in ceramic materials. In addition to the single-shaft and two-shaft Brayton engines, other multi-shaft Brayton concepts are being evaluated. Both swashplate and crankshaft versions of the Stirling engine are being considered. In FY 1978, more effort will be devoted to the diesel (with and without turbocharging), stratified charge (reciprocating and rotary versions of the Otto engine), and Otto power systems. Future plans for the ATSP Proj. include completion of the first annual technology assessment report in Apr 1978. TTS documents covering the alternative engine installed horsepower sizing, the baseline Otto power system, and the Brayton power system will be completed during FY 1978.

by M. W. Dowdy
California Inst. of Tech., Jet Propulsion Lab.
Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),
"Highway Vehicle Systems Contractors Coordination Meeting
(13th) Summary Report," Washington, D.C., 1978 p17-27
1978; 1ref
Conference held in Dearborn, Mich., 4-6 Oct 1977. Research sponsored by Dept. of Energy.
Availability: In HS-024 450

HS-024 452

VEEP--A VEHICLE ECONOMY, EMISSIONS, AND PERFORMANCE SIMULATION PROGRAM

The purpose of the Jet Propulsion Lab.'s VEEP (Vehicle Economy, Emissions, and Performance) Simulation Prog. is to

predict vehicle fuel economy and relative emissions over any specified driving cycle, to calculate various measures of vehicle performance (acceleration, passing maneuvers, gradeability, top speed), and to give information on the various categories of energy dissipation (rolling friction, aerodynamics, accessories, inertial effects, and component inefficiencies). The vehicle is described on the basis of detailed subsystem information and detailed numerical parameters characterizing the components of a wide variety of self-propelled vehicles. The current effort is concentrated on conventionally-arranged heat-engine powered automobiles, but with consideration in the design toward the requirements of other types of vehicles. These include, in the planned next phase (for FY 1978), capability to simulate operation of electric and hybrid vehicles by adding the logic and modules peculiar to their description to the present VEEP program. To date, most of the data management and user interaction procedures have been completed, along with the design and coding. Some engineering-oriented work remains to be done in the simulation modules, and is currently being emphasized. Completion of the program including documentation and user's guide is expected early in FY 1978. VEEP will then be made available for outside use through the Computer Software Management Information Center.

by Gerhard J. Klose
California Inst. of Tech., Jet Propulsion Lab.
Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),
"Highway Vehicle Systems Contractors Coordination Meeting
(13th) Summary Report," Washington, D.C., 1978 p28-31
1978
Includes questions and comments from conference participants. Conference held in Dearborn, Mich., 4-6 Oct 1977. Research sponsored by Dept. of Energy.
Availability: In HS-024 450

HS-024 453

USPS [U.S. POSTAL SERVICE] LIGHT DELIVERY VEHICLES PROGRAM

The Postal Service has a program to look at improved vehicles as fleet candidates to achieve minimum vehicle costs and to reduce the use of, and dependence on, oil-based fuels. This fleet includes approximately 100,000 light-duty, 1/4-ton and 1/2-ton vehicles; test and evaluation of engines and propulsion systems for this group of delivery vehicles are underway. The present development effort includes conversion, test, and evaluation of diesels; evaluation of stratified-charge engines; evaluation of hydrogen fuel energy sources, both liquid and metal hydride; development and evaluation of electric vehicles and improvements; and development and evaluation of the electric/flywheel system. Performance tests such as acceleration, speed, and gradeability are conducted. Simulated delivery route tests are conducted on a closed-loop track. Based on the results of the simulated route tests, decisions are made to conduct operational tests. Usually, a minimum of two test vehicles are assigned to each selected location. Each of these vehicles, along with a gasoline engine vehicle used for comparison, are operated in turn on selected routes over a period of time. Results are used to project comparative performance on delivery routes. It is too early to predict the ultimate results of the current test and evaluation efforts, but they appear to be

the most promising avenues for improvement for the Postal Service.

by Wilson E. Hull
Postal Service

Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),
"Highway Vehicle Systems Contractors Coordination Meeting
(13th) Summary Report," Washington, D.C., 1978 p31-40
1978

Includes questions and comments from conference
participants. Conference held in Dearborn, Mich., 4-6 Oct
1977.

Availability: In HS-024 450

HS-024 454

DOE/GSA [DEPT. OF ENERGY/GENERAL SERVICES ADMINISTRATION] MICROFLEET EVALUATION OF THE MORSE CONTROL SPEED ACCESSORY DRIVE

An automotive accessory drive, the Control Speed Accessory Drive (CSAD), has been developed which serves as a power take-off for all accessories normally driven from the engine crankshaft. This accessory drive is primarily speed-responsive with the driven load contributing some effect on the output speeds. By limiting accessories speeds and, therefore, lowering parasitic horsepower losses, improvements in overall vehicle fuel economy are attained. Test results show maximum savings of 8% to 13%. An additional benefit is increased accessory life due to the smaller speed range encountered by using the accessory drive. The CSAD currently is being downsized to fit a greater number of applications since the trend is toward V-6 and V-4 cylinder in-line engines as standard equipment. These engines generally have shorter crankshaft to water pump center distances than a V-8 engine. Federal damageability standards limit the proximity of the cooling fan to the radiator. It is the space between the fan and the accessory v-belt lines into which a variable ratio belt and pulleys must fit. This space must be approximately 1 and 1/8" consisting of the top width of the main belt itself, the belt's axial travel, the pulley halves' wall thicknesses, and their clearance from the accessory v-belts. To use the energy-savings potential of this device, it may be necessary to reposition some accessories; and the consumer and manufacturer both must accept an additional, though slight, complication under the hood.

by C. Wollard

Borg Warner Corp., Morse Chain Div.

Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),
"Highway Vehicle Systems Contractors Coordination Meeting
(13th) Summary Report," Washington, D.C., 1978 p40-51
1978

Conference held in Dearborn, Mich., 4-6 Oct 1977.

Availability: In HS-024 450

HS-024 455

ORGANIC RANKINE BOTTOMING CYCLE FOR LONG HAUL DIESEL TRUCKS

The organic Rankine bottoming cycle, due to its relatively high cycle efficiency at moderate peak cycle temperatures of 550 degrees F to 650 degrees F, offers the best potential for converting automotive waste energy to useable shaft power and thus reduce fuel consumption. The most attractive use of this cycle system is in large, heavy-duty diesel trucks for long-

distance hauling. Here, the engine load and speed requirements are nearly constant over a large portion of the operating hours, and high mileages are accumulated. Thus, the potential fuel savings are sufficient to justify the added cost of a bottoming cycle system. The addition of an organic Rankine bottoming cycle to a long-haul diesel truck can improve the fuel economy by 15% over a typical duty cycle. This represents a potential reduction of 1.8 billion gal/yr (120,000 barrels/day) in the near-term transportation fuel requirements. Emission levels also would be reduced by an amount equal to the gain in efficiency. Proof-of-concept tests have been conducted with a Mack 676 diesel engine and an organic Rankine bottoming cycle (not specifically designed for this application). At the peak power condition, 36 additional hp were produced, a gain of 13% in power without additional fuel. Testing is currently in progress on a completely integrated system utilizing the same diesel engine coupled with a three-stage organic Rankine turbine. Future activities will include continued dynamometer testing of this system and installation of a similar system in a typical long-haul tractor.

by Robert Raymond

Thermo-Electron Corp.

Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),
"Highway Vehicle Systems Contractors Coordination Meeting
(13th) Summary Report," Washington, D.C., 1978 p52-67
1978

Includes questions and comments from conference
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1977.

Availability: In HS-024 450

HS-024 456

SUMMARY OF VARIABLE DISPLACEMENT ENGINE PROJECT

A variable-displacement, five-cylinder, spark-ignition research engine has been designed, fabricated, and tested. This design reduces partial-load fuel consumption by reducing throttling and friction losses. Power is controlled by changing the piston stroke rather than by throttling, except at idle and very low power levels. A linkage arrangement allows for continuous changes in stroke and, therefore, in engine displacement. The prototype has a bore of 3.375 in, and stroke varies from 1 to 4 and 1/4 in as displacement varies from 43 cu in to 190 cu in. The linkage concept is such that clearance volume can be changed in proportion to the stroke. Thus, nearly constant compression ratio (CR) can be achieved, or (by proper selection of the linkage dimensions) CR can be tailored to optimize the design. During design, dynamic analyses of various configurations of the engine were made to determine member loads and unbalanced forces and to assist in selecting the linkage configuration. Dynamic analysis also was used to select five as the number of cylinders, to determine the firing order, to reduce engine vibration, and to compare vibration with that of a conventional engine. An engineering model of the engine fluid dynamics also was developed to predict engine performance, to select cam contours, and to optimize cam timing. Test results from this variable-displacement engine have shown brake specific fuel consumption that is less dependent on load than in throttled engines and averages slightly less than 0.5 lb/brake hp-hr over the range of speeds and power levels required in most driving situations. Data and analysis indicate that this type engine may improve Environmental Protection Agency urban-cycle gasoline mileage 20% to 30% over 1976 automobiles in the 3500 lb inertial weight class. Durability has been demonstrated by over 375 hr of dynamometer test-

ing, with no measurable wear of the connecting rod bearings, crankshaft, cylinders, or pistons. It remains to be seen if this engine concept will be durable enough for the American family car and whether the fuel economy projections can be realized during in-vehicle operation at statutory emissions levels.

by C. W. Robinson
Sandia Labs.

Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),
"Highway Vehicle Systems Contractors Coordination Meeting
(13th) Summary Report," Washington, D.C., 1978 p67-73
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1977.

Availability: In HS-024 450

HS-024 457

HYDRO-MECHANICAL TRANSMISSION DEVELOPMENT FOR PASSENGER CAR FUEL ECONOMY IMPROVEMENT

A continuously variable transmission (CVT) is being developed for application to automobiles. The transmission is of the hydromechanical type, in which the power is split between a geartrain and a speed-changing component consisting of a variable-displacement hydrostatic pump and motor. Current development is focused on application of the transmission to a spark-ignition engine and compact car in the 3500 lb inertial weight class. It is the purpose of the CVT to control engine speed to maximize engine efficiency and, thereby, improve fuel economy without incurring unacceptable penalties in emissions, driveability, or vehicle cost. In the past eight months, in-vehicle transmission testing has proceeded far enough to confirm the availability of a 20% fuel economy improvement as predicted at the outset of the project. In addition to chassis dynamometer testing, considerable effort is being devoted to upgrading the driveability; and several transmission control features have been modified to improve smoothness of clutch shifting, stability of engine speed, and the minimization of engine speed error. In view of the penalties in both fuel economy and wide-open-throttle acceleration associated with errors in the engine speed, improvements in transmission control are having a direct impact on both measures of vehicle performance. Noise generated by the hydrostatic module has been reduced considerably but still needs improvement. Although the first prototype hydromechanical transmission is fulfilling the project objectives by demonstrating fuel economy improvement, it is both bulky and overweight. Further engineering and design efforts are leading to a pre-production prototype which will have a minimum weight, bulk, and cost penalty relative to the current production three-speed automatic transmission and which is expected to be very competitive with a conventional automatic transmission having four speeds and a torque converter with lock-up clutch.

by Peter Huntley

Orshansky Transmission Corp.

Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),
"Highway Vehicle Systems Contractors Coordination Meeting
(13th) Summary Report," Washington, D.C., 1978 p73-93
1978

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participants. Conference held in Dearborn, Mich., 4-6 Oct
1977.

Availability: In HS-024 450

HS-024 458

DEMONSTRATION OF HYDRAULIC MODULE FOR AN AUTOMOTIVE HYDROMECHANICAL TRANSMISSION

A test program was undertaken to demonstrate the performance characteristics of the hydraulic pump-motor module of a continuously variable transmission (CVT), the transmission being developed to investigate the potential improvements in vehicle fuel economy which could result from its use. The configuration uses a novel construction of a hydrostatic module arranged in a tandem axial relationship with output planetary gearing. The modular hydrostatic construction provides direct connection to the engine input, and the gearing permits effective noise isolation and has minimum structural requirements. The configuration is attractive in that it uses a proven control system and conventional automotive design, and is compatible in size (envelope), weight, and cost with current transmissions. The single most critical component is the hydraulic unit. In this test program, the hydraulic axial piston pump and motor were sized for a 100 hp engine and built as a test module. The hydraulic module has been found to have high overall efficiency, particularly at low speeds and torques. This high efficiency becomes important in fuel economy improvement since much of the automobile operation is at a low road load and speed. Throughout the testing, the module has proved completely reliable. After the initial debugging period, testing has continued without interruption. The results have provided a major step in demonstrating the feasibility of the CVT for automotive application.

by Paul Lewis

Mechanical Technology Inc.

Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),
"Highway Vehicle Systems Contractors Coordination Meeting
(13th) Summary Report," Washington, D.C., 1978 p94-101
1978

Conference held in Dearborn, Mich., 4-6 Oct 1977. Research
sponsored by Dept. of Energy, and subcontracted to
Mechanical Technology Inc. by Chrysler Corp.
Availability: In HS-024 450

HS-024 459

IMPROVING AUTOMOBILE FUEL ECONOMY WITH ACCESSORY DRIVES

The last phase of a five-phase research program has been completed successfully to define, evaluate, and develop automotive accessory systems to minimize engine power consumption and significantly improve fuel economy in relation to near-term applications; a follow-on program effort will study and recommend systems for mid-1980 advanced Stirling and turbine engines. Having established the benefits associated with constant-speed accessories, the final phase was initiated to evaluate further accessory optimization in the areas of air conditioning (A/C), the largest power consumer, and hybrid drives, using alternative vehicle power sources (exhaust (turbo accessory compounding), fuel (accessory engines), deceleration (regenerative braking), and exhaust and cooling (Rankine bottoming)). The goal for hybrid drives and advanced A/C systems (including the constant speed principle) was set at 10% to 14% fuel economy improvement. Based on modeling and evaluation of the feasible combinations in the Mustang II simulator, the least complex configuration, with the best suited packaging arrangement, includes the "off-peak" flywheel drive and variable-delivery, screw compressor A/C. This system

produced an Environmental Protection Agency composite fuel economy improvement of 7.3%, which is 48% of maximum achievable. The Rankine bottoming, hybrid accessory drive, combined with variable-delivery, screw compressor A/C developed the highest composite fuel economy improvement potential of 11.3%. This second system achieved 75% of maximum attainable. The third configuration combines "off-peak" flywheel drive with turbo-compressor, waste heat A/C, to produce a composite fuel economy improvement of 11.1%. Improving the impact of accessory system loads on fuel economy by 75% is considered a significant gain, but the cost-effectiveness associated with development and production of the required hardware is disappointingly poor. Positive recommendations on what to pursue are constant-speed accessory drives, improvement in accessory operating efficiency and load-matching techniques, development of variable-delivery A/C compressors, and consideration of accessory system design as an integral part of powerplant design.

by C. H. Lefferts

AiResearch Co., Ariz.

Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96), "Highway Vehicle Systems Contractors Coordination Meeting (13th) Summary Report," Washington, D.C., 1978 p101-24 1978

Conference held in Dearborn, Mich., 4-6 Oct 1977.

Availability: In HS-024 450

HS-024 460

GAS TURBINE PROJECT STATUS

The three goals of the Gas Turbine Proj. being managed by the National Aeronautics and Space Administration (NASA) are to provide the necessary technology base within the U.S. automotive industry so that it can initiate production engineering development of improved gas turbine systems by 1983 (an improved gas turbine system is one which incorporates existing or near-term technology; has at least a 20% gain in fuel economy over current spark-ignition (SI) engines; compares favorably with respect to noise, driveability, reliability, and life-cycle cost; and is capable of meeting the strictest emission levels of exhaust gas without penalizing fuel economy); to define an advanced gas turbine system by 1983 (one which incorporates significant advances in technology, and has a 50% to 60% gain in fuel economy over the SI engine, while meeting the same goals of the improved gas turbine engine); and to develop the technology required for the advanced systems in a timely manner, so that production of these systems is possible in the 1990's. The first element of the project is to complete the development of the Chrysler Upgraded Engine, a program started in 1972 and to be completed in 1978. Its objective was to define the state of the art of automobile gas turbine technology, particularly with respect to fuel economy and emissions. The second element, the Improved Gas Turbine Systems Devel., will be carried out through parallel contracts with the automotive industry. A two-phase program is planned, one dealing with conceptual design and program planning, the other with system development. The third element, Advanced Systems Definition, will be carried out through selective contracts with industry and through NASA in-house studies. Effort will be made to define promising candidates, assess evolving technology, and guide the supporting research and technology activities. The last element is Supporting REs. and Technology. Several technology areas have been identified as key to the development of the gas turbine system and include high-temperature ceramic materials, low-emission combustors, high-temperature heat exchangers, ad-

vanced bearings and seals, advanced transmissions, advanced turbomachinery, and advanced manufacturing processes. Efforts will be conducted through industry contracts, university grants, and a small amount of in-house work.

by W. E. Goette

National Aeronautics and Space Administration, Lewis Res. Center

Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96), "Highway Vehicle Systems Contractors Coordination Meeting (13th) Summary Report," Washington, D.C., 1978 p125-9 1978

Conference held in Dearborn, Mich., 4-6 Oct 1977.

Availability: In HS-024 450

HS-024 461

STATUS OF THE CHRYSLER UPGRADED GAS TURBINE ENGINE PROGRAM

The Chrysler Upgraded Gas Turbine Engine Prog. is currently utilizing five engines (three being used in test cells for engine development (two at Chrysler, one at the National Aeronautics and Space Administration (NASA)), and two installed in vehicles). Of the two engines still to be built, one will be instrumented for development toward minimizing bulkhead cooling and the other will be for a third car. Although no formal endurance study has been undertaken, 600 hr of accumulated testing have revealed no significant mechanical problems. Of the two running vehicles, one is being used principally for exhibit, the other for control and general vehicle system development. The corrective development program has been extended to mid 1978 to allow for design modification of the turbomachinery. Constraints have been eased to allow designs which should eliminate the present 25% power shortfall. Verification testing of these designs is targeted for Mar 1978. Retrofitting program demonstration vehicles with parts to the new designs would complete this phase of the program. A task to study the automotive gas turbine improvement potential has been added to the program, paralleling separate studies being conducted by other automobile manufacturers under NASA contracts. Some preliminary ceramic material development and assessment activities are included in this effort. Current efforts to meet goal power are structured to eliminate aerodynamic deficiencies. Further efforts also are needed to meet the brake specific fuel consumption goal. Accordingly, efforts are underway to reduce excessive bulkhead cooling and to increase regenerator effectiveness by improving the distribution of flow through the matrix.

by C. E. Wagner

Chrysler Corp.

Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96), "Highway Vehicle Systems Contractors Coordination Meeting (13th) Summary Report," Washington, D.C., 1978 p129-43 1978

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Availability: In HS-024 450

HS-024 462

LEWIS RESEARCH CENTER SUPPORT OF CHRYSLER UPGRADED ENGINE PROGRAM

One of the areas in which the National Aeronautics and Space Administration's (NASA) Lewis Res. Center is supporting the

Chrysler Upgraded Gas Turbine Engine Prog. is in engine testing. The Center's advanced engine facilities, instrumentation, and on-line computer capabilities are being used to support the program. Originally, it was planned that gas turbine engine testing at Lewis would be to determine the design improvement primarily on the Upgraded Engine, but subsequent developments have altered these plans. Running of the Upgraded Engine has indicated that, although the engine is mechanically sound, it is deficient in power. Recent modifications and corrective action have improved this situation, but there is still more work needed to reach the design goal. Lewis Res. Center is supporting the Chrysler corrective action program by additional testing of the Upgraded Engine and evaluating component performance. The compressor, burner, and compressor turbine need to be improved. The power turbine will be affected by changes made to improve the compressor turbine. Now that the NASA-Lewis test cell is operational, plans in the near term are to characterize the upgraded Engine 5-4 to 100% NgG, and assist Chrysler in correcting the Upgraded Engine performance, and, in the far term, determine the performance of component designs proposed for use in an advanced engine, and investigate advanced transmission concepts.

by E. L. Warren

National Aeronautics and Space Administration, Lewis Res. Center

Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96), "Highway Vehicle Systems Contractors Coordination Meeting (13th) Summary Report," Washington, D.C., 1978 p143-9 1978

Includes questions and comments from conference participants. Conference held in Dearborn, Mich., 4-6 Oct 1977.

Availability: In HS-024 450

HS-024 463

IMPROVED HEAVY DUTY GAS TURBINE ENGINE PROGRAM

General Motors' Heavy Duty Gas Turbine Engine (HDGTE) Prog. was initiated in 1976 with research on ceramic components for testing in a baseline engine (for initial ceramic regenerator disk chemical stability evaluation) and in the initial engine purchased by the program (Engine C-1). The study was conducted to establish a viable Phase 2 program which could result in demonstration of ceramic components by 1981 (extended to 1982) with significant test-stand engine hours and with vehicle demonstrations using ceramic components. The baseline engine testing was accomplished at regenerator inlet temperatures of 1425 degrees F to 1450 degrees F; 1800 hr of accumulated engine test time have shown chemical stability of the aluminum-silicate heavy-wall regenerator disks (hub-drive geometry) made by Corning Glass. Engine C-1 testing was initiated in Sep 1977 and over 100 hr of testing have been accomplished on ceramic regenerator disks of rim-drive geometry. Ceramic vanes (silicon carbide (SiC) and silicon nitride (Si₃N₄)) and stationary turbine tip shrouds (SiC and Si₃N₄) are being made ready for Engine C-1 testing. In the second phase of the program, 1900 degrees F engine testing will continue, and a vehicle demonstration with ceramic components will be made late in 1978; 2070 degrees F engine testing will begin in 1979 with a vehicle demonstration in late 1980; 2265 degrees F engine testing will begin in 1981 with a vehicle demonstration in 1982 and the target 0.35 specific fuel consumption demonstration in 1982. New ceramic geometry vanes, shrouds, and regenerators will be introduced during

1900 degrees F testing; ceramic turbine inlet plenum and rotor blades at the 2070 degrees F test temperature level; and improved-efficiency regenerators, compressor, gasifier turbine, and power turbines at 2265 degrees F, along with a ceramic combustor and exhaust diffuser.

by H. E. Helms; Franklin A. Rockwood

General Motors Corp., Detroit Diesel Allison Div.

Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96), "Highway Vehicle Systems Contractors Coordination Meeting (13th) Summary Report," Washington, D.C., 1978 p149-64 1978

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Availability: In HS-024 450

HS-024 464

STATUS OF FORD REGENERATOR SYSTEMS DEVELOPMENT [GAS TURBINE ENGINES, CERAMIC MATERIALS]

Ford Motor Co.'s program to develop chemically-resistant ceramic heat exchangers for use in turbine and Stirling engines and waste-heat recovery systems has the specific objective of demonstrating a regenerator B10 life of 10,000 hr at 800 degrees C (1472 degrees F). The eight major tasks of the program are engine tests at 800 degrees C, engine tests at 1000 degrees C (1832 degrees F), screening tests of new materials, performance tests in shuttle rig, design of advanced regenerators, material stability tests up to 1200 degrees C (2192 degrees F), cost study update, and material specification update. Over 130,000 core-hr of engine testing at 800 degrees C have been accumulated using the Ford 707 industrial turbine engine. Two chemically-resistant materials, aluminum silicate (AS) and a lower-cost magnesium aluminum silicate (MAS), have been under test for several years. Seven AS cores have accumulated over 4000 hr of engine test, and three AS cores together with a single MAS core have had over 5000 hr of engine exposure. A thick-wall AS core and a thin-wall AS core are now on test at a temperature of 982 degrees C (1800 degrees F). Data accumulated in the last six months continue to show that AS and MAS have the potential of achieving the program objective. None of the cores shows any serious signs of chemical-attack damage over the test period. A problem still exists in elastomerically bonding a ring gear to a thin-wall AS core. A single thin-wall core with a high-compliance elastomer design has accumulated 2000 hr without distress, but a larger sample is needed before any conclusions can be drawn. A thick-wall AS core has now accumulated almost 3500 hr at 982 degrees C without damage. Several new materials, including second-generation MAS compositions, are now undergoing laboratory and engine screening tests for chemical-attack resistance and elevated temperature capability. Future plans call for continued testing at 800 degrees C and 1000 degrees C. Laboratory testing of ceramics up to 1200 degrees C will continue so that the temperature limitations of present and future regenerator materials can be determined.

by C. S. Rahnke

Ford Motor Co.

Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96), "Highway Vehicle Systems Contractors Coordination Meeting (13th) Summary Report," Washington, D.C., 1978 p165-74 1978

Conference held in Dearborn, Mich., 4-6 Oct 1977.

Availability: In HS-024 450

HS-024 465

HSL 79-06

HS-024 465

DEVELOPMENT OF COMPLIANT FOIL BEARINGS FOR AUTOMOTIVE GAS TURBINES

Hydresil compliant foil bearings have been developed for the turbine end of the gas generator in the Chrysler gas turbine engine and are being used in the engine program at 60,000 rpm and temperatures of 500 degrees F to 600 degrees F. Currently, limited developmental work is continuing in which the main emphasis is on long-term reliability of the bearing-rotor system and on delivery of engine bearings. Bearings in service for over one year have shown the following: no fundamental bearing-rotor problems; foil bearing received a good workout during fuel system early tuning and development of other engine components; and individual bearings have logged over 100 hours with many start and stop cycles. Developmental work at a low level for the last six months has been concerned with continued simulator study of the oil bearing-damper system, improvements in bearing coating life, and procurement of seals for stability influence studies. Foil bearing materials and coatings technology advancement studies being conducted consist of two parts, a study of basic journal bearing technology and the development of high-temperature foil bearing surface lubricant coatings for a 1200 degrees F environment. Some recent studies of interest performed in a single journal bearing test rig include journal bearing load performance at temperature and effects of journal surface finish, study of cooling air requirements for 600 degrees F, comparison of actual bearing performance with current computer analysis, and development of high-temperature materials and coatings. Some additional foil bearing development work has been performed which both complements and extends some of the previous programs; this work involves activities related to the establishment of an air foil thrust bearing facility, foil bearing material development, and additional studies of the influence of floating carbon ring seals on rotor stability.

by Stanley Gray

Mechanical Technology Inc.

Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),

"Highway Vehicle Systems Contractors Coordination Meeting (13th) Summary Report," Washington, D.C., 1978 p174-94 1978

Conference held in Dearborn, Mich., 4-6 Oct 1977.

Availability: In HS-024 450

HS-024 466

FABRICATION AND TESTING OF SILICON NITRIDE TURBINE ROTORS

While there are many complex shaped ceramic components in a 2500 degree F engine, the most complex and highly stressed component is the duo-density turbine rotor. The high strength of hot-pressed silicon nitride (Si₃N₄) is used in the hub region where stresses are highest, but temperatures are moderate; and, therefore, creep resulting from the use of a magnesium densification additive is minimized. The blade ring is made from reaction-bonded Si₃N₄, which can be formed into complex airfoil shapes by injection molding or slip casting. Although the reaction-bonded material is of lower density, and, thus, lower strength, it is adequate for the turbine blades since stress levels in this region are lower than in the hub, and particularly since the creep resistance of the reaction-bonded material is superior at high temperature to that of the hot-pressed Si₃N₄, mainly due to higher chemical purity. The hub is formed and bonded to the blade ring in one hot-pressing

operation. During the last year, significant progress has been made in injection-molding flaw-free blade rings and in eliminating damage to the blade ring during the hot-pressing operation by inclusion of an automatic control system in the injection-molding operation. This system is being used currently to define more precisely optimum molding parameters so that quality can be improved further. Hub bonding and densification problems occurring during the hot pressing of rotor were eliminated by changing from the three-piece contoured hub to the flat-sided, two-piece design. Subsequently, by initiating control procedures in the blade filling process, a 70% yield of rotors free of hot-pressing flaws was obtained. The test of a particular rotor has demonstrated for the first time that a Si₃N₄ turbine wheel can operate at high speed and withstand a temperature of 2500 degrees F. Testing of ceramic rotors in the engine is continuing.

by D. L. Harstock

Ford Motor Co.

Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),

"Highway Vehicle Systems Contractors Coordination Meeting (13th) Summary Report," Washington, D.C., 1978 p194-208 1978

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Availability: In HS-024 450

HS-024 467

REVIEW OF DURABILITY TESTING OF STRUCTURAL CERAMICS

During the past year, ceramic materials research has been conducted in three areas: development of sinterable silicon nitride (Si₃N₄), proof testing methodology, and durability testing of structural ceramics. With respect to developing sinterable Si₃N₄, preliminary additive and process screening was carried out in FY 1977, and several promising routes to attaining the objective have been isolated (the use of N₂ over-pressure, use of additives which promote diffusion, and control of starting powder size distribution and "green" density of precursor compacts). The FY 1978 program will focus on processing optimization, scale-up studies, and preliminary property evaluation for both the oxide and non-oxide additive systems. With respect to improving the reliability of ceramic turbomachinery components via mechanical and thermal proof testing, material test specimens have been used to determine the statistical and time-dependent strength characteristics of selected high-temperature engineering ceramics (NC-132 and Ford HPSN (hot-pressed Si₃N₄) Rotor Hub Material). The data will be used to correlate analytical life predictions based on subcritical crack growth with experimental observations. The program also includes an investigation of fast fracture testing techniques to proof-test for longterm operation. All data have been collected for the Modulus of Rupture (MOR) of NC-132; data acquisition on the current hub material (3.5 wt% MgO (magnesium oxide)-Si₃N₄) is continuing; double cantilever testing of NC-132 fracture toughness and slow crack growth samples in specially constructed test rigs has commenced. The purpose of the materials durability testing is to obtain mechanical property data to verify long-time (2000 hr to 4000 hr) integrity of current ceramic gas turbine hot flow path materials under conditions of thermal cycling to 2500 degrees F; the main emphasis will be on combined thermal exposure and thermal cycling in oxidative environments, and stress rupture tests in air. To date, several ceramic materials (NC-132, NC-350, NC-203, and KBI-RBSN (reaction-bonded Si₃N₄)) have been subjected to

360-hr exposure and 500 thermal cycles. Stress-rupture testing at 1200 degrees C (2200 degrees F) has been conducted on NC-132 and KBI-RBSN. On NC-132 the data imply a static fatigue limit of about 35 ksi (MOR). The results of stepped-stress-rupture testing indicate time-dependent failures at 1100 degrees C and above. The results of stress-rupture testing of KBI-RBSN indicate that at 1200 degrees C fracture is not time-dependent, and that, if one stays below about 27 ksi (MOR), no failures are encountered. However, the stepped stress-rupture testing indicates time-dependent failure at 1000-1100 degrees C (1832 degrees F), possibly attributable to oxidation. Stress-rupture and stepped-stress-rupture data will be accumulated on NC 203 and NC 350 material in the first quarter of FY 1978, and on NC 433 - RS SiC, Ford-RBSN and G.E. SIL/COMP-Si/SiC during the second and third quarter.

by R. N. Katz

Army Mechanics and Materials Res. Center

Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),

"Highway Vehicle Systems Contractors Coordination Meeting (13th) Summary Report," Washington, D.C., 1978 p208-24 1978; 15refs

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Availability: In HS-024 450

HS-024 468

HEAT EXCHANGER MATERIALS BASED ON LITHIUM AND MAGNESIUM ALUMINUM SILICATES [VEHICULAR GAS TURBINE]

A program is underway to develop a ceramic material with appropriate physical and chemical properties for application as a construction material for a heat exchanger in a vehicular gas turbine. The major requirements are low thermal expansion between ambient and 1000 degrees C and the ability to operate at least for short times at temperatures up to 1100 degrees C. To satisfy this goal, the material should have strength, thermal expansion, thermal phase stability, and thermal shock resistance comparable to, or better than, current materials, but must have improved corrosion resistance. Very recent data have shown that combining magnesium aluminum silicate (MAS) with lithium aluminum silicate (LAS) yields materials with good corrosion resistance and lower expansion than MAS. Observations suggest that LAS/MAS materials (LMAS) and LMAS plus iron aluminum titanate (FAT) may offer potential for use in gas turbine heat exchanger applications. Other second phases are being considered as well for incorporation into the basic MAS body which may lower the overall expansion yet preserve the superior chemical and dimensional stability of these materials. During the past year, a 3:2 LAS:MAS composition (GE-3200) was further optimized and chosen for fabrication and testing. Numerous expansion, cycling, corrosion, and strength data were obtained on samples of the material which had been made into a rectangular cross-section honeycomb full-size heat exchanger wheel; the samples were fired to 1260 degrees C (2300 degrees F). The GE-3200, when compared to standard Corning 9455 compositions, had significantly better resistance to both sulfuric acid and sodium chloride, had higher thermal expansion, had higher mechanical properties in the tangential direction and lower in the radial direction (partially related to fabrication), and had a tendency to elongate between room temperature and 1000 degrees C to 1100 degrees C rather than to contract. Of importance is the fact that the GE-3200 was found to have rheological properties significantly better than some other compositions, apparently primarily due to the mixture's

heterogeneous nature. The structure can be fabricated and fired with a minimum of distortion and shrinkage. A sample batch was provided to NGK Insulators, Ltd., Japan, for fabrication testing.

by Louis R. McCreight

General Electric Co.

Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),

"Highway Vehicle Systems Contractors Coordination Meeting (13th) Summary Report," Washington, D.C., 1978 p224-5 1978

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Availability: In HS-024 450

HS-024 469

IMPROVED HEAT EXCHANGER MATERIALS [VEHICULAR GAS TURBINE]

A program is underway to develop a ceramic material with physical and chemical properties suitable for a heat exchanger in a vehicular gas turbine. The major thrust of the program is toward improved resistance to chemical attack by sulfuric acid (H2SO4) and sodium salts. The development materials must exhibit, however, low thermal expansion between ambient and 1000 degrees C (1830 degrees F) and the ability to operate at least for short times up to 1100 degrees C (2000 degrees F). To satisfy this goal, the material should have strength, thermal expansion, thermal phase stability, and thermal shock resistance comparable to, or better than, current materials. The following lithium aluminum silicate (LAS) compositions have been selected from five original study compositions and have been further tested, in comparison with Corning Material 9460 AS (aluminum silicate): C-144 leached LAS material whose major crystalline phase is silica keatite plus mullite, C-145(4-1) LAS material whose major crystalline phase is keatite solid solution, 4-2 Modified No. 4-1 altered for improved H2SO4 resistance, and 4-3 Modified No. 4-1 altered for improved H2SO4 resistance. Material C-144 was found to be comparable to Corning 9460 AS in having excellent H2SO4 resistance. Material 403 had improved H2SO4 resistance compared to C-145 and 4-2, but only fair acid resistance compared to C-144. Initial test results indicate C-144 and C-145 are comparable to Corning 9460 with respect to Sodium Chloride (NaCl) resistance; these materials had fair resistance to NaCl at 1000 degrees C; C-145 had better resistance than materials 4-1 and 4-2. For thermal expansion after 50 hr at 1000 degrees C, all materials had an acceptable thermal expansion of less than 800 ppm delta L/L change in length from ambient to 1000 degrees C. Material C-144 had superior thermal expansion stability to 1100 degrees C and 1200 degrees C exposure compared to Corning 9460. Material C-144 had the best dimensional stability at 1000 degrees C, expanding 50 ppm delta L/L after 100 hr, while C-145 expanded 125 ppm and 9460 contracted -125 ppm; materials 4-2 and 4-3 contracted about -250 ppm. Material C-144 had superior dimensional stability at 1100 degrees C after 40 hr with zero change in length, vs. 9460 which contracted -1200 ppm; C-144, C-145, 4-2, and 4-3 had acceptable dimensional stability after 100 hr changing length less than 200 ppm. Future work includes evaluating honeycomb matrix open frontal area with respect to wall thickness and seal cross-arm wear, optimization of the glass-ceramic fabrication process, and a cost study. Matrix test cores with adequate seal arm abrasion resistance will be delivered to Ford, Detroit Diesel

gram.

by K. Kormanyos
Owens-Illinois, Inc.
Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),
"Highway Vehicle Systems Contractors Coordination Meeting
(13th) Summary Report," Washington, D.C., 1978 p225-38
1978; 1ref
Conference held in Dearborn, Mich., 4-6 Oct 1977.
Availability: In HS-024 450

HS-024 470

ALUMINOUS KEATITE AS A REGENERATOR MATERIAL

A Corning aluminous keatite material as both thin-wall (T14-20) and thick-wall (T20-38) structures has been tested in industrial gas turbines at Ford and Detroit Diesel Allison. It has been found that there is a need to increase the strength (Modulus of Rupture and Young's Modulus) of the T14-20 material so that its better heat transfer characteristics can be exploited fully. The present program is to improve the T14-20 strength so that higher thermal performance at part load can be achieved. The future success of ceramic regenerators is believed to depend on thin-walled material. Effort also is directed toward increased matrix hardness and increased operating temperature capability. The present objective is 1200 degrees C which is believed to be feasible with these materials. Fuel and environmental contaminant limit tests will be completed. A test rig is running at Corning with a 28-in core at temperatures up to 1200 degrees C. It has the capability of injecting both fuel and air-entrained contaminants, and is now operating 24 hr/day, 7 days/wk.

by John G. Lanning
Corning Glass Works
Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),
"Highway Vehicle Systems Contractors Coordination Meeting
(13th) Summary Report," Washington, D.C., 1978 p238-40
1978
Conference held in Dearborn, Mich., 4-6 Oct 1977.
Availability: In HS-024 450

HS-024 471

STIRLING ENGINE PROJECT STATUS

The three objectives of the Stirling Engine Hwy. Vehicle Systems Prog. being managed by the National Aeronautics and Space Administration (NASA) are an improved engine production engineering decision by industry in 1984-1985, advanced engine definition by 1983, and development of enabling technology for advanced engine production in the 1990's. An "improved" Stirling engine is one that uses existing or near-term technology, exhibits a 30% fuel economy advantage over a comparable 1976 spark-ignition (SI) engine, and can meet the statutory emission requirements of the Clean Air Act as amended. An "advanced" engine will utilize significant technology advancements, will exhibit a 50% fuel economy advantage, and will meet or better the emission requirements. Both engines must be market-competitive with stratified-charge SI, diesel, and gas turbine engines. A cost-shared improved engine development program will be carried out with the U.S. auto industry in order to help that industry establish for itself the option of entering into a production engineering program for Stirling engines in 1984-1985. The advanced en-

gine will be provided by supporting research and technology activities in appropriate industry segments and universities, supplemented by a small amount of NASA in-house work. Ford Motor Co. has already contracted to carry out an improved engine program; a parallel study is planned for a second team. Some work was started in FY 1977 in the support area. A Stirling materials technology assessment was completed. The Illinois Inst. of Tech. Res. Inst. has contracted to research hydrogen permeability in metals and ceramics. Seals work is underway at Boeing and at the Univ. of Toledo. The Univ. of Washington is carrying out a survey of available Stirling cycle design techniques. Small engine tests are being conducted at NASA to provide basic performance data.

by R. G. Ragsdale
National Aeronautics and Space Administration, Lewis Res. Center
Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),
"Highway Vehicle Systems Contractors Coordination Meeting
(13th) Summary Report," Washington, D.C., 1978 p241-3
1978
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HS-024 472

IMPROVED STIRLING ENGINE DEVELOPMENT

Due to the innovative design and inherent complexity of the Stirling engine, the amount of test data accumulated to date by Ford Motor Co. in testing a 170-hp Stirling engine, the 4-215 Stirling, is limited. The major innovations incorporated in this engine are as follows: 200 atmospheres working gas pressure (vs. 150 atm. for previous engines), first engine with rotary ceramic preheater system, new air/fuel control system to satisfy dynamic requirements, new power control system for automobile demands, three times larger than previous swash-plate engines, half the specific weight of previous Stirling engines, packageable within existing engine compartments, 4000 rpm capability vs. 2000 rpm to 3000 rpm of rhombic drives, first engine with exhaust gas recirculation, unique coolant flow through cooling units, new lubrication system, and first engine designed to drive full range of automotive-type accessories. Based on two CVS-CH (constant volume sampler) and three engine dynamometer tests which are believed to represent the capability of the engine at its present stage of development, the best fuel economies using gasoline are 12.6 mpg and 14.4 mpg, respectively. Use of diesel fuel would yield an additional 11% increase in economy. With additional improvements now underway, it is believed that the Phase 1 objective of 15.7 mpg will be achieved. Initial emission tests on the Stirling-powered vehicle have resulted in HC (hydrocarbon) and NOx (nitrogen oxides) levels both above the low-mileage and 50,000-mi objectives (0.2 g/mi and 0.41 g/mi; 0.2 g/mi and 0.4 g/mi, respectively). With improved burner operation, dynamometer tests have resulted in HC and NOx levels below the 50,000-mi objective; however, NOx and CO (carbon monoxide) levels were still higher than the low-mileage objectives (1.7 g/mi for CO). Other tests on the Stirling engine have disclosed that acceleration performance of the engine is 16.0 sec (0 mph to 60 mph) vs. the objective of 12.7 sec, that initial vehicle curb weight is about 50 lb over objective (50 lb over baseline), and that the start-up time is 24 sec (key-on to driveaway) vs. objective of 15 sec. It is believed that the present Stirling hardware can es-

sentially meet the objectives of the development program; primary features of such an engine will be excellent fuel economy (20.6 mph), multi-fuel capability, low emissions level, and low noise level (70 dBA). It will take eight years to complete the program and will require some \$160 million.

by Norman D. Postma

Ford Motor Co.

Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),

"Highway Vehicle Systems Contractors Coordination Meeting (13th) Summary Report," Washington, D.C., 1978 p243-54 1978

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HS-024 473

INITIAL TEST RESULTS WITH SINGLE CYLINDER RHOMBIC DRIVE STIRLING ENGINE

In support of the Stirling Engine Hwy. Vehicle Systems Prog. being managed by the National Aeronautics and Space Administration (NASA), NASA has restored to operating condition an 8-hp, single-cylinder, rhombic drive Stirling engine. It is mounted in an engine-generator set, designed as GPU 3-2 (Ground Power Unit). The engine-generator set was built by General Motors Res. Labs. in 1965 for the U.S. Army and recently has been tested by NASA using helium and hydrogen as the working gas. Initial test results for the GPU 3-2 generator unit indicate that brake specific fuel consumption (BSFC) fell within the range of Army BSFC data. BSFC was calculated from NASA helium and hydrogen test data using efficiency data supplied by the alternator manufacturer. The minimum BSFC observed during the tests was 0.88 lb/hp-hr at 4 hp vs. 0.61 lb/hp-hr at about 8 hp from Army dynamometer data. Operation with helium substantially reduced the power output capacity of the engine. The maximum power output with helium was about half that for hydrogen. The maximum engine power achieved during these tests was somewhat lower than that observed during Army tests, but it is expected that the power output can be improved with some additional component repair and replacement. Overall, it is felt that the GPU 3-2 engine is operational and that, with additional instrumentation and some modification to improve operating flexibility, it will become a valuable research tool. New parts are being made for the second GPU 3 engine; after rebuilding GPU 3-1 there will be two fully instrumented research engines. This will allow for greater continuity in testing and comparative testing. Testing data will be used to verify NASA's Stirling engine computer simulation models. These engines will also be used as test beds to evaluate advanced component concepts and control systems, particularly heat exchangers, seals, materials, and engine controls.

by James E. Cairelli

National Aeronautics and Space Administration, Lewis Res. Center

Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),

"Highway Vehicle Systems Contractors Coordination Meeting (13th) Summary Report," Washington, D.C., 1978 p254-8 1978

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Availability: In HS-024 450

HS-024 474

EVALUATION OF RECIPROCATING SEALS FOR STIRLING CYCLE ENGINE APPLICATION

A program for the development of rod seals that will provide a significant improvement in leakage, power loss, and life over elastomeric O-rings in the adverse environment of the Stirling engine is in the design stage. The first part of the program involves a review of three rod seal designs to identify demonstrated or anticipated improvements over conventional O-rings; the second part involves the design and fabrication of a test system for evaluating two selected seal designs; the third part involves evaluation testing of the seals using a laboratory simulator, the results to provide either confirmation of seal adequacy as a part of the Stirling engine system or valuable data for use in defining future research to develop an improved seal. To date, the two seal configurations have been selected and approved (the NASA (National Aeronautics and Space Administration) polyimide chevron seal, and the Boeing foot seal). The designs for the test system and one of the two seal retention fixtures for the system have been completed. Work will proceed on completing the design of the second test fixture and initiating procurement and fabrication of parts. Testing will begin in the first few months of 1978 to determine friction, leakage, and wear characteristics of the selected seals.

by A. W. Waterman

Boeing Commercial Airplane Div.

Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),

"Highway Vehicle Systems Contractors Coordination Meeting (13th) Summary Report," Washington, D.C., 1978 p258-67 1978

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Availability: In HS-024 450

HS-024 475

MATERIALS TECHNOLOGY ASSESSMENT FOR STIRLING ENGINES

An investigation is underway to assess the current state of the art of metals and ceramics that are potential candidate materials for hot components in the improved or advanced Stirling engine; to identify materials research, development, and testing required to support the development of automotive Stirling engines; and to recommend materials technology program plans to assure material readiness in time with engine system development programs. Based on the information available to date, the heater head is considered to be the most critical component in the improved (metal) engine from a materials viewpoint. Time, stress, and environment impose stringent requirements for the alloys to be used. Mechanical rupture data such as rupture life are required for candidate alloys under anticipated operating conditions. Calculated permeation rates of hydrogen indicate that barrier coatings will be required. Hydrogen compatibility, permeation, and effects on properties need to be measured on candidate uncoated and coated alloys. Strategic material use must be minimized, and must be considered a primary design factor. Based on available mechanical property data, lower cost alloys can be substituted for N-155 (a highly alloyed iron-base alloy composed of 31% iron, 20% nickel, 21% chromium, 20% cobalt, and 7% columbium-molybdenum-tungsten) and still meet current estimated stress

to date indicate that zinc ceramic materials, silicon carbide and silicon nitride, are potential candidates for application in the advanced (ceramic) Stirling engine, there is a paucity of data on these materials under estimated engine operating conditions. Because of the high temperature of the air preheater, this component is considered to be the most critical from a materials position. Long-term stability data under the operating conditions of the heater head are needed. Environmental effects (hydrogen and combustion gases) must be evaluated. Fabrication technology must be developed for the various components where ceramics will be utilized in the advanced Stirling engine.

by Joseph R. Stephens
National Aeronautics and Space Administration, Lewis Res. Center
Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),
"Highway Vehicle Systems Contractors Coordination Meeting (13th) Summary Report," Washington, D.C., 1978 p267-74
1978
Includes questions and comments from conference participants. Conference held in Dearborn, Mich., 4-6 Oct 1977.
Availability: In HS-024 450

HS-024 476

SURVEY OF STIRLING ENGINE ANALYTICAL DESIGN METHODS

A Stirling engine design manual currently is being developed which will organize and evaluate the information available in the literature on all aspects of Stirling engines, particularly the information needed to design a Stirling engine for a particular application. One section of the manual will deal with the three orders of Stirling engine design methods. The first-order methods are useful for system studies. For already optimized engines, this method roughly shows how engine performance relates to operating conditions. The second-order methods assume that relatively simple formulas can be used to compute the power output and the mechanical and thermal losses. This method is short enough to be used for design optimization of the engine. The third-order methods employ rigorous nodal analysis of the actual engine process with few approximations. Unfortunately, the basic heat-transfer and flow-friction data applicable to Stirling engine conditions presently are not available and the validation of the results of analysis with engine measurements has not been done in most cases. Third-order methods will be useful for engine research.

by W. R. Martini
University of Washington
Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),
"Highway Vehicle Systems Contractors Coordination Meeting (13th) Summary Report," Washington, D.C., 1978 p274-86
1978; 8refs
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HS-024 477

THERMAL ENERGY STORAGE/HEAT ENGINE FOR HIGHWAY VEHICLE PROPULSION

An ongoing program involves system studies to assess the economic and technical feasibility of thermal energy storage

device, a heat engine, and a power transmission/differential to drive the wheels. The concept should have inherent compatibility with any heat source that provides the required storage temperature, e.g. 1000 degrees K. Electric resistance, solar heating, and the combustion of a fuel are all possible. Once charged, the TES/heat engine propulsion system operates with zero exhaust emissions and with low noise. The Stirling cycle heat engine appears to be the best choice. The actual performance of the TES/Stirling engine propulsion system will be influenced by the thermal insulation system. The fully-charged TES unit will lose heat continuously and must be used swiftly and completely to realize peak performance. At this point, the program concerns only the TES system, namely, the thermal storage, thermal insulation, heat transport devices, heat delivery controls and the interface between the thermal storage and the thermal recharge system. The output heat transfer surface of the TES system is the input heat transfer surface of the heat engine. The heat engine is not a part of the TES program. The TES total energy and power levels appropriate for a compact vehicle/heat engine/powertrain combination have been calculated on a consistent basis. For example, cruising at 88 kph requires 55.5 kW from the thermal storage. In order to drive 160 km at this speed, 101 kW-hr would be demanded from the thermal storage, making its temperature drop from the initial value of 1158 degrees K to 1101 degrees K.

by L. R. Folsom
Mechanical Technology Inc.
Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),
"Highway Vehicle Systems Contractors Coordination Meeting (13th) Summary Report," Washington, D.C., 1978 p286-303
1978; 10refs
Conference held in Dearborn, Mich., 4-6 Oct 1977.
Availability: In HS-024 450

HS-024 478

ALTERNATIVE FUELS UTILIZATION PROGRAM (AFUP) REASSESSMENT

The role of the Alternative Fuels Utilization Prog. (AFUP) is to establish technological links between government and the automobile and fuel industries through which government resources can be used to support and, therefore, accelerate research and development on fuels utilization. The goal of the AFUP is to lower uncertainty costs (direct dollar costs, social costs, costs of information, etc.) associated with alternative fuel utilization technologies in the highway vehicle system, and to foster the use of such fuels (new hydrocarbon (HC) fuels including broad-cut and variable composition fuels initially from petroleum, and eventually from coal, shale, biomass, etc.; and alcohol fuels including methanol, the higher alcohols, and HC blends). For new HC fuels in the near term, it is planned to achieve and evaluate multi-fuel operation in research engines of the continuous combustion types, as well as in present and developmental internal combustion engines. For HC fuels in the longer term, plans are to achieve and evaluate new systems in order to optimize the resource/fuel/engine system for efficiency, emissions, performance, manufacturability, and marketability. For alcohol fuels in the near term, it is planned to test and evaluate alcohol-gasoline blends in commercial or government fleets, ultimately to prove their reliability and feasibility. For alcohol fuels in the longer term, it is planned to achieve and evaluate new systems in order to optimize the resource/fuel/engine system based on alcohols and

to detail the desired emissions and efficiency improvements projected for alcohols in optimized engines. For synthetic gasoline and diesel fuels in the near term, it is planned to test and evaluate these fuels in current and improved current engine types. Advanced fuels and new fuels will be assessed for possible use in the highway vehicle system. It is also planned to determine what nonstandard fuels might be used in existing engines in order to maintain the reliability of the highway vehicle system during an emergency situation.

by C. J. Anderson

Lawrence Livermore Labs.

Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96), "Highway Vehicle Systems Contractors Coordination Meeting (13th) Summary Report," Washington, D.C., 1978 p305-11 1978

Includes questions and comments from conference participants. Conference held Dearborn, Mich., 4-6 Oct 1977. Availability: In HS-024 450

HS-024 479

IDENTIFICATION OF PROBABLE AUTOMOTIVE FUELS COMPOSITION: 1985-2000

A study to develop methodology to be utilized in projecting most probable compositions of hydrocarbon (HC) and methanol automotive fuels in the period 1985-2000 in the U.S., using domestic nonpetroleum resources (oil shale and coal) in their manufacture, is about to be completed. The approach in the development of the methodology was to define the reference resources of coal and shale, examine the various conversion to syncrude processes, identify engine requirements, and identify refinery modifications. The methodology has been established; compositional factors are critically contingent upon syncrude conversion process parameters which require further development and definition. If the emerging syncrudes-synfuels industry develops at currently foreseeable rates, such syncrudes will be blended with petroleum crudes in such a manner as to have no impact on conventional automotive fuels composition.

by John A. Russell

Southwest Res. Inst.

Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96), "Highway Vehicle Systems Contractors Coordination Meeting (13th) Summary Report," Washington, D.C., 1978 p311-33 1978

Includes questions and comments from conference participants. Conference held in Dearborn, Mich., 4-6 Oct 1977. Availability: In HS-024 450

HS-024 480

AUTOMOTIVE HYDROGEN STORAGE WITH MAGNESIUM HYDRIDE

Metal hydrides can store more hydrogen per unit volume than normal high-pressure or cryogenic techniques. Little energy is required to store the hydrogen in the hydride, and high stability at room temperature ensures low losses over long storage periods. Safety features of metal hydride storage are favorable. Because of its low weight and high hydrogen storage densities, modified magnesium hydride (MgH₂) offers the greatest potential for automotive storage of hydrogen. Recent experimental and analytical work has been directed toward the optimization of this storage system. Because of the relative sta-

bility of MgH₂, modifications of the form MgMH_z (M equals metal ion) have been made to decrease the dissociation temperature while retaining high hydrogen capacity. This parameter is crucial since vehicle exhaust will supply the thermal energy to dissociate the hydride in an automobile. System studies indicate that hydride dissociation temperature should be 200 degrees C to ensure uninterrupted fuel flow at all driving and idle conditions. Experimental studies have shown that modified Mg-Ni (magnesium-nickel) alloys offer the greatest potential for reaching that goal. Dissociation temperature at one atmosphere hydrogen pressure is reduced to 204 degrees C for an alloy of Mg, Ni, Cu (copper), Si (silicon), and Y (yttrium) from 302 degrees C for MgO.9NiO.1Hx. Nickel content has been reduced to 24% from 55% in Mg₂NiH_x. Dissociation temperatures as low as 223 degrees C have been achieved with alloys containing 10% Ni.

by D. A. Rohy

Solar Turbine International

Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96), "Highway Vehicle Systems Contractors Coordination Meeting (13th) Summary Report," Washington, D.C., 1978 p334-41 1978

Includes questions and comments from conference participants. Conference held in Dearborn, Mich., 4-6 Oct 1977. Availability: In HS-024 450

HS-024 481

DATA FOR DESIGN OF A HYDROGEN ENGINE; A PROGRESS REPORT

An effort is underway to develop a data base for hydrogen engine design and also hydrogen fuel system design, as well as to organize existing hydrogen engine data. No particular design or mode of operation is recommended at this time. The data base is still being generated, and a small fraction is presented. A number of critical hardware items have been identified including the hydrogen tanks, hydrogen heat exchanger and the need for close temperature control, roto meter (hydrogen), inclined manometers (air) for flow measurement, carburetors, injection systems, venturi meters, water-injection systems, and exhaust gas recirculation system. Data generated so far include brake thermal efficiency (BTE) vs. brake mean effective pressure (BMEP); NO_x (nitrogen oxides) emissions vs. BMEP; effect of water injection on NO_x emissions, BTE, and best efficiency spark advance during the throttled and unthrottled modes of operation; percent NO_x emissions reduction vs. water-injection rate; and uncorrected BTE vs. fuel-air equivalence ratio.

by Robert R. Adt, Jr.; Michael R. Swain

University of Miami

Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96), "Highway Vehicle Systems Contractors Coordination Meeting (13th) Summary Report," Washington, D.C., 1978 p341-50 1978

Includes questions and comments from conference participants. Conference held in Dearborn, Mich., 4-6 Oct 1977. Availability: In HS-024 450

HS-024 482

HSL 79-06

HS-024 482

ALTERNATIVE FUELS FOR INTERCITY TRUCKING SYSTEMS

A study is underway to compare past and contemporary alternative fuels work with the needs and problems unique to intercity trucking systems (with focus on large tractor-trailer units), to document the organizational and equipment characteristics of intercity trucking systems and to identify the problems that would be created by the transition to alternative fuels, and to present a preliminary program plan to assist industry and government planners in developing an effective alternative fuels utilization plan for intercity trucking. The following is a preliminary alternative fuels list: most probable (distillate oils from coal, distillate oils from oil shale, methanol from coal), less probable (methanol from biomass, condensable synthetic gases from coal and oil shale, hydrogen), and least probable (acetylene, ammonia, carbon monoxide, hydrazine, vegetable oils). Preliminary observations regarding engine systems are that several alternative fuels have not been evaluated in diesel engines, relatively little work has been done on developing injection systems for alternative fuels with poor lubricity or cyrogens, and there is need for justification of investment in such research. Preliminary observations regarding tractor conversion for alternative fuels are that quantitative information on economics, safety, maintenance and repair, operations impact, etc., of alternative approaches to conversion of tractor units is unavailable; and justification of either analytical or hardware programs to obtain such data seem to be dependent on the value of the information in contributing to an understanding of the problems of conversion on a large scale with varying strategies.

by William J. D. Escher

Escher Technology Associates

Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),

"Highway Vehicle Systems Contractors Coordination Meeting (13th) Summary Report," Washington, D.C., 1978 p350-2 1978

Conference held in Dearborn, Mich., 4-6 Oct 1977. Research sponsored by Dept. of Energy and Ryder Prog. in Transportation at Univ. of Miami.

Availability: In HS-024 450

HS-024 483

NON-PETROLEUM FUELS AND COMPATIBLE ENGINES--1977 BERC [BARTLESVILLE ENERGY RESEARCH CENTER] UP-DATE REPORT

Experimental work designed to provide information for best utilization of nonpetroleum transportation fuels has been underway at the Bartlesville Energy Res. Center since shortly after the 1973 oil embargo. The work has focused on fuels and engine systems that could be introduced or adapted in the very short term as a means to alleviate shortfall or potential shortfall in traditional supply, and on fuels that might be produced from oil shale or from coal as supplementary or replacement resources for petroleum. The time frame is from the early 1980's through the turn of the century. The fuels selected for study included alcohols and like materials; traditional fuels, gasoline and diesel, from nonpetroleum sources; and modified traditional fuels. Parallel consideration of engines has focused on conventional spark-ignition engines for the alcohol and gasoline fuels, and on diesel, stratified-charge, and Stirling engines for fuels heavier than gasoline. The major effort thus far on methanol blends has been in a study of the physical proper-

ties of gasoline/methanol mixtures, and an experimental study that involved 11 late-model automobiles operated both in the laboratory and on the road to generate information on the use of blended methanol/gasoline fuel. Initial work with straight methanol centered on experimentation with two research-type systems in which methanol can be adequately used; these are a conventional Bendix fuel-injection system utilizing a custom-designed electronic control that enables ready adjustment of air-fuel ratio, and a multi-orifice, high-turbulence carburetor utilizing positive air metering and positive follow-up fuel delivery. Experimental work is now underway to generate data on the fuel economy, emissions, and power delivery characteristics of a current technology engine adapted for methanol fuel. Tests with various engines have also generated data on coal- and shale-derived fuels. The FY 1978 experimental program with synthetic fuels will focus on broad-boiling-range fuels and high-efficiency engine systems in which the low-cetane, low-octane fuels are acceptable. In the main, these criteria coupled with widely-held current views on engine technology lead to stratified-charge engines and to spark-assisted diesels for the reciprocating category and to Stirling engines in the category of continuous combustion. Results to date indicate no serious problems in realizing good mutual accommodation of evolving engines and synthetic fuels. For best efficiency, combustion systems must be designed and adjusted for specific fuel properties; parallel development of fuels and compatible engines must occur.

by R. W. Hurn

Dept. of Energy, Bartlesville Energy Res. Center

Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),

"Highway Vehicle Systems Contractors Coordination Meeting (13th) Summary Report," Washington, D.C., 1978 p352-62 1978; 5refs

Includes questions and comments from conference participants. Conference held in Dearborn, Mich., 4-6 Oct 1977.

Availability: In HS-024 450

HS-024 484

ALCOHOL/GASOLINE BLENDS--LEAN MISFIRE LIMITS

A study was undertaken to examine lean-mixture operating characteristics of a multi-cylinder spark-ignition engine fueled with a blend of methanol and gasoline. While lean-mixture operation is beneficial from emissions and energy conversion efficiency standpoints, as the mixture is made excessively lean, misfiring and/or erratic combustion commences resulting in unstable operation. The fuel-air equivalence ratio at which misfiring and/or erratic combustion occurs is generally termed the lean misfire limit (LML). This study showed that there is an extension of the LML when a 20% methanol blend is substituted for Indolene (gasoline). This LML extension is attributed to an extension of ignition failure to leaner mixtures with the blend. Of the commonly-used LML detection methods, it was found that the counting of motoring cycles, as ascertained from in-cylinder pressure transducer measurement, is more sensitive than the monitoring of hydrocarbon (HC) emissions. The sensitivity of counting misfires audible at the exhaust pipe was found to fall between those of the two methods. The sensitivity of the standard deviation of the leanest cylinder blowdown-pulse pressure as an LML detector was determined to be about the same as the sensitivity of the method using motoring-cycle frequency. Based on considerations of engine and fuel-related LML behavior, it is suspected that the extension of the LML for methanol and methanol

blends is caused by the presence of fuel droplets when ignition occurs with these fuels.

by Robert R. Adt, Jr.
University of Miami
Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),
"Highway Vehicle Systems Contractors Coordination Meeting
(13th) Summary Report," Washington, D.C., 1978 p362-5
1978; 3refs
Includes questions and comments from conference
participants. Conference held in Dearborn, Mich., 4-6 Oct
1977.
Availability: In HS-024 450

HS-024 485

METHANOL UTILIZATION

An experimental program has been underway to investigate various aspects of the utilization of methanol as an automotive fuel. In dynamometer studies using a 2300-cc Ford Pinto engine to compare gasoline vs. methanol, it was found that the power from methanol ranges from 5% to 11% higher, that methanol's thermal efficiency is on the average 10% higher, that NOx (nitrogen oxides) emissions from methanol average a factor of 2 lower, that CO (carbon monoxide) emissions in the lean region are about the same for the two fuels, but lower for methanol in the rich region, that hydrocarbon emissions show a small but discernable advantage favoring methanol, and that aldehyde emissions are higher for methanol ranging from a factor of 1.2 to 10 depending on the equivalence ratio. Three alternative fuel-air induction systems for methanol (WHB shock wave system, the Dresserator Inductor, and the electronic fuel injection (EFI) system) have been under investigation using the same engine. Their collective data indicate improvements in thermal efficiency, power, and exhaust emissions relative to both methanol and Indolene; also, the WHB system has eliminated completely a maldistribution in the fuel-air equivalence ratio which was noted in earlier studies. Comparisons have been made of the alternate fuel systems operating on methanol by simulating urban and highway driving in a Pinto; the Dresserator and WHB systems show promise in increasing fuel economy and reducing exhaust emissions by operating at very lean values. Thermochemical engine process modeling studies have proved very encouraging from both modeling and engine performance points of view. Equilibrium thermodynamic studies have indicated the potential for generating a cold-start gaseous fuel by decomposing methanol. Oil samples from the test engines have indicated differences in engine wear rates of iron, chromium, and lead, using methanol or gasoline, were masked by the influence of variations in speed and load. In the case of copper, methanol causes somewhat higher wear rates, but the differences are small. Studies have indicated that the NO2 (nitrogen dioxide) concentrations in the blowby gases from a methanol-fueled engine are about the same as those from gasoline, interesting in that NOx emissions using methanol are well below those from gasoline. Three street vehicles have been operating on methanol for extended periods with no major fuel system or engine component failures. Photochemical reactivity studies of emissions from a methanol-fueled vehicle are planned. Preliminary assessment of methanol toxicity to small marine and estuarine organisms is encouraging to environmentalists. NOx emissions of a small gas turbine with low combustor inlet temperature

were reduced by as much as 68% with methanol fuel and careful atomization; CO was reduced by 23%.

by Richard Pefley
University of Santa Clara
Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),
"Highway Vehicle Systems Contractors Coordination Meeting
(13th) Summary Report," Washington, D.C., 1978 p365-76
1978; 3refs
Conference held in Dearborn, Mich., 4-6 Oct 1977.
Availability: In HS-024 450

HS-024 486

**ENGINE LUBRICANTS FOR USE IN METHANOL
FUELED HIGHWAY VEHICLES**

To provide an initial screening for problems when methanol fuels are used in conjunction with present commercial lubricants, a series of engine tests was conducted using the Coordinated Lubricants Research single-cylinder engine. This engine was chosen for its ability to provide a number of metallurgical and physical configurations for testing and its ability to obtain samples of blowby gases from the piston-ring zone. Based on test results, it is apparent that pure methanol, at least under certain operating conditions, can result in increased wear in present internal combustion engines using conventional lubricants. While the absolute nature of this increased wear is unknown, apparently corrosive attack plays some part. In addition, in combination with water formed as a combustion product, methanol or its byproducts appear to interfere or precipitate a portion of the lubricant additive package. It appears that to some extent methanol is incompatible with at least one of the commonly-used additive packages on the market today. The present work will be continued with the hope that in the near future the effects of methanol on engine wear can be defined, and lubricant or additive formulations developed to suit present metallurgical designs to methanol fuels.

by E. Owens
Army Fuels and Lubricants Res. Labs.
Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),
"Highway Vehicle Systems Contractors Coordination Meeting
(13th) Summary Report," Washington, D.C., 1978 p377-85
1978
Includes questions and comments from conference
participants. Conference held in Dearborn, Mich., 4-6 Oct
1977.
Availability: In HS-024 450

HS-024 487

**SOLVING ALCOHOL FUEL PROBLEMS BY ENGINE
MODIFICATION**

An in-depth study is underway to identify problems and solutions for retrofitting older vehicles and for designing future vehicles for methanol (and blends) use, should that use become desirable. A careful review of the literature has been made; to date, approximately 300 useful references have been identified and examined. Personal contacts were made with individuals and laboratories with ongoing methanol use studies via a questionnaire on potential methanol fuel use problems. Based on these sources, the following potential problems (type A (most severe), B (moderately severe), or C (relatively minor)) have been identified: for blends, phase separation (A), material incompatibility (B), carburetor design (B), vapor lock

(B), emissions (C), fuel consumption (B), fuel tank capacity and materials (C), safety and toxicity (C), and engine wear (C); and for neat methanol, material incompatibility (A), vapor lock (B), exterior finish damage (B), cold start (A), warm-up (A), steady and transient operation of the hot engine (B), emissions (B), fuel consumption (B), fuel tank (B), safety and toxicity (B), engine wear (B), carburetor design (B), and compression ratio (C). In most cases, even the relatively minor problems could require expensive changes in a retrofit program. A variety of solutions to all the indicated problems have been formulated; these will be judged by fuel economy (Federal standards); exhaust emissions (Federal standards); performance and driveability; multifuel capability; mass production compatibility (tooling requirements); near future availability; installation requirements, time, and cost; maintenance requirements and costs; and safety and health. The approach is to select for study specific vehicles which are thought to be representative of larger groups of vehicles (e.g. 1974-rich carburetion-air pump, 1978-lean carburetion-catalyst, and 1972-lean carburetion-spark retard). The cost and problems of each of several solutions for these vehicles will be developed to evaluate their retrofitting potential.

by D. J. Patterson
University of Michigan
Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),
"Highway Vehicle Systems Contractors Coordination Meeting
(13th) Summary Report," Washington, D.C., 1978 p385-97
1978
Conference held in Dearborn, Mich., 4-6 Oct 1977. Research
sponsored by Dept. of Energy.
Availability: In HS-024 450

HS-024 488

SOLVING ALCOHOL FUEL PROBLEMS BY FUEL MODIFICATION

A methanol fuel modification program is underway to characterize known and potential problems that might be encountered if methanol (and blends) were used widely as an automotive fuel, to evaluate possible solutions obtainable by means of fuel modification, and to recommend where further study and performance testing are needed. A literature search has been made, interviews have been held, lists of problems and potential fuel modifications have been compiled, and laboratory studies to investigate selected problems and evaluate the effectiveness of fuel modifications are well advanced. Some 25 possible problems have been identified and are all attributable to fundamental differences between gasoline and methanol in physical and chemical characteristics such as heat of vaporization, heat of combustion, combustion stoichiometry, solvent properties, and boiling range. Two different methods available for altering these properties are to convert methanol itself into other chemical species with more favorable properties, or to modify fuel composition by adding or removing other components. Examples of the first are conversion to gasoline hydrocarbons (HC) by the Mobil process, conversion to t-alkyl methyl ethers by reaction with olefins, and effective conversion to higher alcohols. The latter includes conversion of carbon monoxide and hydrogen gas partially to higher alcohols instead of to methanol during methanol synthesis. Possibilities for modification by use of additives or other fuel composition alteration are many, and some are discussed. Startability in cold weather is a major problem with neat methanol that can be solved by the addition of 5% to 25% of HC or gasolines.

nonexplosive, the flames of any fire are more visible, and the risks of toxicity are decreased. However, satisfactory driveability in carbureted cars with fuel that is mostly methanol would require modification of the intake system unless methanol were converted largely to other species such as HC. With blends of methanol in gasoline, the major problem of phase separation can be alleviated greatly by adding higher alcohols as cosolvents. Some modification of fuel distribution equipment still would be required to limit entry of water. Mixing of blends with gasoline should be avoided to prevent phase separation caused by fuel incompatibility. The increased tendency to vapor lock which accompanies addition of methanol to gasoline could be controlled by withholding butane, but more fuel energy would be lost than gained. Replacing part of the methanol with higher alcohols to improve water tolerance would also diminish the vapor locking tendency enough to permit a net gain in energy. Conversion of methanol to ethers by reaction with olefins appears to solve many of the problems with blends, but any increase in the fuel supply by this means would be limited severely by availability of suitable olefins.

by James L. Keller
Union Oil Co. of California
Publ: HS-024 450 (DOE-CONF-771037; DOE-UC-96),
"Highway Vehicle Systems Contractors Coordination Meeting
(13th) Summary Report," Washington, D.C., 1978 p397-407
1978
Includes questions and comments from conference
participants. Conference held in Dearborn, Mich., 4-6 Oct
1977. Research sponsored by Dept. of Energy.
Availability: In HS-024 450

HS-024 489

DRIVER ALERT SYSTEM PREVENTS RAILROAD CROSSING HAZARDS [SCHOOL BUSES]

The General Railway Signal Co. (GRS) of Rochester, N.Y., recently developed a new concept in vehicle safety systems designed to increase school bus safety at railroad crossings. In its Driver Alert System (DAS), GRS has developed a product designed specifically to focus the driver's attention on upcoming hazards on his route, particularly railroad crossings, while he is still a safe distance away. The DAS keeps the driver alert by requiring him to perform certain functions as the bus approaches a hazard, showing the system that the driver is aware of the approaching situations. Failure to acknowledge the presence of a railroad crossing sets off an alarm that sounds continuously until the driver brings the bus to a full stop. An option to the DAS provides a similar alarm if the bus fails to stop immediately before the crossing. Any time the alarm sounds, it is recorded on a counter built into the system. In its simplest design, the solid-state system consists of two major components: a signaling device at each rail crossing, and a receiver/logic module in each bus. Also mounted on the bus are an antenna and a small cube containing the acknowledge button and alarm. As added protection, a signaling device at the bus facility driveway verifies that a vehicle's equipment is operating properly as it departs on its route. The Oregon Traffic Safety Commission is considering the DAS for a pilot program. A 1977 study issued by the Dept. of Transportation analysed 10,000 accidents between 1970 and 1975 and showed that almost 58% of accidents involving school buses were caused by bus operator error. Another report which analysed 61 severe accidents including collisions between trains and school buses showed that bus driver error was the cause in

the cases. These illustrate the serious hazard when buses must cross railroad tracks.

School Bus Fleet v23 n5 p28-9 (Oct-Nov 1978)

Ref: See publication

490

REPORT [TOXICITY OF DIESEL ENGINE EXHAUST]

Government would like automakers to hold off substantial expansion of diesel-powered cars until tests have been conducted to determine the toxicity of exhaust. Ames mutagenicity tests already carried out by Environmental Protection Agency (EPA) showed that one strain of bacteria was subjected to diesel exhaust, it went through a mutant transformation. The Ames and other mutagenicity tests are used to make a preliminary selection of vehicles to be tested for carcinogenicity in live animals. The tests so conducted a 50-day inhalation test in which cats, mice, and guinea pigs were exposed to diluted exhaust from a small diesel engine. The test produced increased susceptibility to respiratory infection and deposited exhaust particles in the animals' lungs and body tissues. There was no lung irritation, but no evidence of cancer. The government is planning more tests and comparisons with gasoline-engine exhaust as well as ambient air and coke oven contamination. The Clean Air Act Amendments of 1977 have shifted the burden of identifying offending pollutants and determining the threat to public health from the government to the manufacturers. Beginning with 1979 model year cars, the manufacturers must certify, to the best of their ability, that emission control systems do not cause or contribute to a reasonable health risk. However, from a realistic viewpoint, the 1981 models will be the earliest possibly to be affected by any test findings. To meet fuel economy standards, automakers are expanding production of diesel vehicles. The greatest threat to the diesel passenger car may come not from a possible cancer-causing factor but rather from the nitrogen oxides emission standard. California has requested permission from the Federal government to lower the limit to 0.4 g/mi for cars sold in the state. In the opinion of diesel engineers, this cannot be done with present technology without destroying the diesel's fuel economy advantage, without which it has no reason to exist. If California lowers the standard, Mercedes-Benz will be the major loser, half of the firm's cars sold in the U.S. are diesels and these are sold in California.

Ethridge
Motor Trend v30 n11 p50-1 (Nov 1978)

Ref: See publication

491

TOOL KITS. THE TOOLS OF THE TRADE IN THE BLACKTOP JUNGLE [MOBILE REPAIRS]

Of the automotive failures that statistically occur most often, the tools a motorist will need to make the necessary repairs and the approximate prices for the tools and replacement parts to do the job has been compiled. Information is provided for the following emergency repairs: flat tires, blown

radiator hose, broken fan belt, blown fuses, wet ignition, and dead battery. Also provided are a list of general spare items which might be included in the automobile emergency repair kit (headlight bulb, taillight bulb, ground cable, brake fluid, automatic transmission fluid, power steering fluid), and a list of general equipment to help make repairs safer and cleaner (emergency light, flares, reflector, ground cloth, cotton gloves, hand cleaner, rags).

by Peter Frey
Publ: Motor Trend v30 n8 p98-9 (Nov 1978)
1978
Availability: See publication

HS-024 492

AUTO FINANCING IS A STATE OF MIND

Financial considerations to be made before purchasing (or leasing) an automobile from the standpoints of cost, convenience, and need are discussed. The first decision to be made is whether to borrow money at all to finance a car purchase. For most people, borrowing money is a necessity and the question is where the most attractive loan may be arranged. Because credit unions are expanding rapidly, offer reasonable rates of interest, are easy to use, and have a great deal in common with banks and "captive" finance companies such as General Motors Acceptance Corp., a credit union transaction is used as an example for all canny borrowing. The second factor considered is convenience. The financial aspects of lease vs. purchase are considered. Third, the situation is considered where a person cannot really afford to purchase a car and has to secure a loan wherever possible (usually a finance company or "captive" company). A list of sources of money and interest charged, and a list of Federal agencies charged with enforcement of credit laws are included. Tips on automobile financing are outlined and include the following: decide what is most important (i.e. cost, convenience, or immediate need); find out if you qualify for the optimum loan (or lease) before shopping for a car; shop around for a bank; if using a secured bank loan (or credit union or life insurance), schedule a repayment to yourself, otherwise you are using capital you are not replacing; and, if buying from a dealer and using an independent credit source, include the discount from the dealer as part of down-payment calculations.

by Leon Mandel
Publ: Motor Trend v30 n8 p103-8 (Nov 1978)
1978
Availability: See publication

HS-024 493

ENGINEERS-KNOW YOUR BUSINESS

Four papers are presented which individually discuss the automotive engineer's role in a business aspect of his profession. Topics considered include patent law, marketing, communications with field service network, and company finance.

Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pa. 15096
Rept. No. SAE-SP-432; 1978; 29p 1ref
Part 26 of "Engineering Know-How in Engine Design."
Includes HS-024 494-HS-024 497. Papers presented at Off-Highway Vehicle Meeting, Milwaukee, 11-14 Sep 1978.
Availability: SAE

HS-024 494

HS-024 494

THE ENGINEER AS A PARTNER IN PATENT LAW [AUTOMOTIVE ENGINEER]

Information on patent law is presented as a basic guide to the automotive engineer. Questions answered concern whether or not an invention has been made, what to do when an invention has been made (documentation, witnessing, legal advice, patent protection), what a patent represents, and whether it is better to keep the invention a trade secret or obtain a copyright, trademark, or design registration as opposed to a patent. A sample Certificate of Invention form is illustrated; the form provides a convenient way to be certain that information that may be needed during consideration of the invention is obtained.

by Roy L. Van Winkle
Dresser Industries, Inc.
Publ: HS-024 493 (SAE-SP-432), "Engineers--Know Your Business," Warrendale, Pa., 1978 p1-10
Rept. No. SAE-780885; 1978
Presented at Off-Highway Vehicle Meeting, Milwaukee, 11-14 Sep 1978.
Availability: In HS-024 493

HS-024 495

THE ENGINEER AS A PARTNER IN MARKETING [AUTOMOTIVE ENGINEER]

Parallels between the jobs of the automotive engineer and the marketing specialist in the automobile industry are drawn, with specific reference to General Motors Corp. (GM). The two professions have in common the objective of supplying a product that fulfills a consumer need at a good value. They both approach their work in a similar fashion, the methodical collection of data to ensure the best product to meet the consumer's need. Engineers use a logical, step-by-step approach to problems, using sophisticated measurement techniques and deductive reasoning to arrive at the optimum solution. The marketing specialist attempts to do his job in a carefully-reasoned, fully-informed manner. At GM, for example, questionnaires are sent to new-car buyers of GM and competitive makes on a continuing basis; among the data obtained in the Continuous Automotive Market Information Program (CAMIP) is information relative to owner satisfaction, vehicle quality, buyer behavior in terms of body style and options purchased, make traded in, repurchase intentions, and demographics. This CAMIP information is used basically for making short-term marketing decisions. One way GM approaches long-term marketing questions is by holding product clinics in which production vehicles and future product concepts are exhibited for selected audiences whose opinions are solicited. Not all information is quantifiable, but it is nonetheless critical to judging consumer behavior. If the marketing people have done their job correctly, all the information obtained about the consumer is relevant to the engineer.

by Thomas S. McDaniel
General Motors Corp.
Publ: HS-024 493 (SAE-SP-432), "Engineers--Know Your Business," Warrendale, Pa., 1978 p11-5
Rept. No. SAE-780886; 1978
Presented at Off-Highway Vehicle Meeting, Milwaukee, 11-14 Sep 1978.
Availability: In HS-024 493

HSL 79-

HS-024 496

DEVELOPING A PARTNERSHIP BETWEEN ENGINEERING AND SERVICE [AUTOMOTIVE PRODUCTS]

Concepts deemed necessary to establish a partnership between the automotive engineering and service departments to expedite the handling of field-service problems are outlined. A service engineering department should be established with the engineering department to provide assistance by periodically supplying the service department with updates of engineering changes intended to reduce field failures (list of various changes and pertinent information to reduce field failures on older models; information on adjustments, field rework parts, or replacement of a combination of parts which would reduce field failures; and "before and after" photographs of parts that were changed which cannot be described adequately in written form). It should also supply the service department periodically with question-and-answer sessions for field representatives and training center personnel; provide experimental parts to the service department if there is a question about parts' effectiveness in solving a problem or if there is a concentration of failures in one area that is affecting product reputation; and provide a field liaison engineer to seek out cause in the field, if a problem exists that is inconsistent with engineering testing. The service department should assist the engineering department by having field representatives report on what they feel are engineering-related problems; and providing warranty assistance (supply copies of warranty claims and/or parts regarding a particular field problem requested; and make sure warranty claims provide model, serial number, date first used and date of failure, hours used, information on type of usage, details of failure reported by customer, and part(s) causing failure). Warranty information should be arranged in a form to assure that proper engineering priorities are established. Four monthly warranty reports are required by the engineering department in order that it may arrange top parts by failure rates in the previous model year, the current model years, by warranty costs per parts in use in the previous model and the current model years.

by Bruce M. Graning
Outboard Marine Corp.
Publ: HS-024 493 (SAE-SP-432), "Engineers--Know Your Business," Warrendale, Pa., 1978 p17-21
Rept. No. SAE-780887; 1978
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Availability: In HS-024 493

HS-024 497

THE ENGINEER AS A PARTNER IN FINANCE

The engineer plays a key role in a company's investment budget by providing the technology that can be exploited, as well as the technical capability to implement the projects selected. It is important that he have an adequate knowledge of financial analysis in order to assist in the process of screening projects for economic acceptability. He must be familiar with the capital projects are approved and how they can best satisfy the expectations of top management. A project proposal submitted by an engineer should contain the following information: description of the project; timing of major segments; amount of each type of expenditure; total appropriation; assumptions used; profitability index and sensitivity; projected profit and loss, rate of return, and cumulative cash position.

and general remarks. The engineer encounters two basic situations requiring expenditures of funds: mandatory expenditures such as breakdowns or pre-scheduled maintenance, and expenditures open to choice where decisions are based on whether the investment can be justified by resultant savings and/or revenues. Generally speaking, the engineering budget is made up of three major categories: new product programs, existing product improvement programs and general overall support programs. To develop a new product it is necessary to formulate a business plan; conduct initial feasibility, marketing and economic studies; develop prototype models; conduct major product development through the design phase; build a pilot plant; prepare final marketing and economic studies, and build the necessary plant and equipment. The business plan is the heart of new product development because it contains project justification and implementation. Its essential elements are purpose, marketing program, engineering program, product costs, process description, facility layout, time schedule, product performance criteria and economic evaluation. A cash flow table is the frame of reference common to all alternative choice problems; it serves as a basic format and schedule that establishes the pattern of all costs and revenues associated with a given project; it provides the means by which to compute income taxes; and gives the year-by-year cash flow from which profitability can be calculated. The table is simple to construct, consistent with accounting, depreciation and income tax concepts, and readily adaptable to all business-type problems. The engineer as a partner in finance is important because capital is limited and engineering projects once approved have a long-term impact on the company; because engineering projects must be approved by top management who use financial criteria on which to base a decision; because projects once approved have to follow some time/money sequence, which requires continuous technical and financial monitoring; and because capital budgeting is a necessary prerequisite to project approval.

by Julian A. Piekarski
Pace Associates Inc., Milwaukee, Wis.
Publ: HS-024 493 (SAE-SP-432), "Engineers--Know Your Business," Warrendale, Pa., 1978 p23-6
Rept. No. SAE-780888; 1978; 1ref
Presented at Off-Highway Vehicle Meeting, Milwaukee, 11-14 Sep 1978.
Availability: In HS-024 493

HS-024 498

THE 55 MPH CHALLENGE

Overwhelming evidence indicates that the 55 mph speed limit has proven to be a significant fuel conservation and life-saving measure. Almost all state police and highway patrol officers strongly support the limit, but enforcing it has presented them with a serious challenge. In the face of fixed or decreasing budgets and increased demands for other police services, state law enforcement administrators are confronted with a serious resource allocation dilemma. In the absence of mandated speed enforcement performance guidelines or compliance criteria, the resource allocation trade-off usually assigns a low priority for patrol of Interstate and other controlled access roads. Unless more funds are provided for state law enforcement activities, most police administrators believe speeds will continue to increase. The Dept. of Transportation (DOT) has recommended to Congress additional funding for enforcement during the years 1979 through 1982. In addition, the National Hwy. Traffic Safety Administration (NHTSA) is involved with or is planning numerous technical activities designed to assist

states in improving their 55 mph enforcement programs (technical assistance teams, public information workshops, 55 mph enforcement workshops, research and development efforts, publications). The development of a precise and uniform standard as to what constitutes acceptable enforcement or satisfactory performance with regard to the 55 mph speed limit, which would be both effective and equitable to all states, does not appear feasible. However, speed limit compliance can be uniformly monitored, measured, and quantified. Increased voluntary compliance must remain a major goal of the 55 mph program at both the state and Federal levels. This can best be achieved by a combination of effective enforcement and strong public information campaigns at the state and local levels. In addition to a national media campaign (TV commercials, radio spots, newspaper and magazine advertisements, bumper stickers, flyers), DOT is committed to assisting states in their own public information efforts. The regional enforcement concept is particularly effective in states which serve as "pass through" points for vacationers and business travelers. DOT is assisting Operation C.A.R.E., a joint enforcement program over the 1977 Labor Day weekend by Michigan, Indiana, Ohio and Illinois, and now a national program, by printing that program's materials. Currently, the visibility of police, mobile radar equipment, the unpredictable movement of enforcement patrols, and reinforcing public information programs are still the best means of achieving compliance.

by Joan Claybrook
National Hwy. Traffic Safety Administration, Washington, D.C. 20590
Publ: Police Chief v65 n9 p26-8 (Sep 1978)
1978
Availability: See publication

HS-024 499

DRIVERS' KNOWLEDGE OF SPEED LIMITS: A STUDY BASED ON POLICE RECORDS

As an initial exploration of the hypothesis that many drivers exceed speed limits because they are unaware of the limit, data from Thames Valley (England) police reports of speeding cases were examined. Analysis of the drivers' reasons for speeding, as recorded on the police forms, indicated that 9% of the motorists were unaware of the speed limit, but it was not possible to distinguish between those who were genuinely ignorant of the limit and those who merely feigned ignorance in the hope of escaping prosecution. In 49% of the cases (total of 415), the drivers were recorded as having made no reply to the question of why they were speeding. Other responses involved admitting offense (6%), not being aware of speed and not monitoring speedometer (8%), giving ambiguous answers implying some lack of knowledge of limit or own speed (5%), being in a hurry (3%), and various other answers (20%). Those drivers who were exceeding the limit by a large amount were more likely to admit their offense than those exceeding the limit by a small amount. Drivers stopped in a 30 mph zone were more likely than drivers stopped in a 40 mph zone to say they did know what the limit was; this was a statistically significant difference. Drivers stopped in a 40 mph zone were also less likely to say they were not monitoring their speed. There was a tendency for drivers who were farthest from home to say they did not know the limit than those who were closest to home. It was concluded that the usefulness, for research purposes, of data obtained from statements made to police officers is doubtful. An alternate approach might be to

use civilian interviewers to question stopped motorists. The interviewers could ask the speeding motorists what they thought the speed limit was and compare their answers with the actual speed limit.

by R. A. Cameron
Transport and Road Res. Lab., Road User Characteristics
Div., Crowthorne, Berks., England
Rept. No. TRRL-SR-382; 1978; 17p 4refs
Availability: Corporate author

HS-024 500

EVALUATION OF A HIGH-DECELERATION BRAKING SIGNAL IN A DRIVING SIMULATOR

An experiment was undertaken to evaluate drivers' response in situations where a leading vehicle decelerates at an unusually high level, and to determine whether the use of a braking magnitude deceleration signal (signals on the rear of cars indicating level of braking) is likely to reduce rear-end collisions. Four alternative modes of displaying braking magnitude deceleration information (the normal two stop lamps, one on each side of the rear, operated at 130 candelas; a yellow lamp in the center rear of the vehicle operated at 130 candelas; a yellow lamp in the center rear of the vehicle operated at 1000 candelas; and a red lamp in the center rear of the vehicle operated at 1000 candelas) were evaluated in a driving simulator. Drivers responding to a post-test questionnaire felt that the signals were useful, but no benefits were found in car-following or crash-related performance measures.

by Rudolf G. Mortimer; Samuel P. Sturgis
University of Michigan, Hwy. Safety Res. Inst.
Publ: "Human Factors Society Annual Meeting (21st)
Proceedings," Santa Monica, 1977 p558-61
1977; 11refs
Meeting held in San Francisco, 17-20 Oct 1977.
Availability: Human Factors Society

HS-024 501

TIRE EXAMINATION FOLLOWING ACCIDENT

Information is presented for conducting a technical examination of tires and wheels in order to determine at what point damage to a tire or wheel occurred in a series of events constituting a motor vehicle accident. Steps in technical examination of a tire include identification of the following: particular tire examined (make or brand and serial or examiner's special labeling), source vehicle and location of tire on the vehicle (may be done by number referring to accident report or other available documents), accident or other event leading to the examination (may be done by referring to accident report or other documents), time and place of examination, examiner, circumstances leading to the examination, and ultimate disposition of the tire and wheel. The size and kind of tire and wheel are described in brief. A search is made for abnormalities in the tire and wheel; each abnormality needs to be described in some detail, especially if the tire and wheel cannot be kept for future reference. Whatever circumstances each abnormality indicates are then specified. The final step involves inferring, if possible, when in the accident sequence the tire-wheel combination was disabled. Samples of tire examination records are included; photographs are recommended, particularly if the tire and wheel cannot be retained by the examiner. Other sources of information about the circumstances of tire or wheel damage may be obtained from marks on roads

at an accident scene, or from statements by persons involved in an accident or by tow-truck operators, and from examination of the source vehicle.

by J. Stannard Baker
Northwestern Univ., Traffic Inst., Evanston, Ill.
Rept. No. PN-83; 1977; 1ref
Advanced Accident Investigation Series.
Availability: Corporate author

HS-024 502

ANALYSIS OF THE AMPUTEE-DRIVER WAIVER PROGRAM

In order to determine the 1973 accident experience of commercial-vehicle drivers with amputee/physical impairment waivers (Part 391.49, Federal Motor Carrier Safety Regulations, as amended 21 Oct 1964), information concerning accidents involving these drivers was obtained from the participating carriers. Seventy-two drivers are represented in the statistics as being actively employed as drivers. No fatalities resulting from the 21 accidents in this study were found. There were 7 injuries, resulting from 4 of these accidents. Of the 21 accidents, 17 were property-damage-only accidents. Five of the 21 accidents were reportable under present reporting criteria, and only 11 of the 21 would have been reportable under pre-1973 accident reporting criteria. Five of the 17 property-damage-only accidents were considered major accidents (property damage losses averaging \$5500); the other 12 averaged \$253. Using the pre-1973 accident reporting criteria, the accident rate per million miles for this type of driver was 2.68; this figure is identical to that of all Class I and Class II motor carriers of property reporting accidents in 1970. The study supports the contention of the Bureau of Motor Carrier Safety that the present waiver program is serving its intended purpose, that of affording capable drivers with good safety records, but who have an amputation or physical impairment the opportunity to drive commercial motor vehicles in interstate commerce. The Bureau has concluded that permitting amputees to operate commercial vehicles in interstate commerce, under controlled conditions, constitutes no greater risk to highway users than commercial drivers generally. No changes in the program are contemplated.

Bureau of Motor Carrier Safety, Washington, D.C. 20590
1974; 5p
Availability: Corporate author

HS-024 503

ASSESSMENT OF THE APPLICATION OF AUTOMATIC VEHICLE IDENTIFICATION TECHNOLOGY TO TRAFFIC MANAGEMENT. FINAL REPORT

A detailed review was performed of the applicability of automatic vehicle identification (AVI) and automatic vehicle monitoring (AVM) technologies to current and emerging traffic management strategies. Six traffic management strategies for which AVI or AVM may be potentially useful were examined in detail. These included congestion pricing, traffic restraint truck restrictions, preferential lane usage, corridor control and traffic signal control. For each application, the relative costs and effectiveness of AVI or AVM vs. the best non-AV method were compared. It was concluded that AVI and AVM technologies can be used to support a variety of present and

suggested traffic management techniques. Three useful AVI capabilities are collecting user charges, restricting vehicle access, and providing enhanced traffic data. These capabilities can be employed potentially either to provide greater effectiveness in achieving the traffic management objectives or to reduce cost through replacement of other equipment or activities. Based on the six prototypical traffic management activities, however, no single current or proposed application appears to warrant using AVI or AVM technology at present, even if vehicles already were equipped with AVI transponders. If multiple traffic management applications for a single city are considered, the use of AVI possibly may be justified in some cases if vehicles already have transponders; however, this situation is unlikely. It is suggested that AVI technology will be warranted for traffic management applications only if the transponders are installed on all vehicles in the nation for other purposes. AVI options possibly can be justified ultimately on the basis of several public and private uses, e.g. toll roads, parking garages, fleet monitoring applications, and traffic law enforcement activities.

by R. A. Ferlis; R. Aaron Peat, Marwick, Mitchell and Co., 1025 Connecticut Ave., N.W., Washington, D.C. 20036; Peat, Marwick and Partners, Toronto, Ont., Canada; Casciato, White and Associates, Toronto, Ont., Canada
DOT-FH-11-9198
Rept. No. FHWA-RD-77-87; PB-282 658; 1977; 45p 12refs
Appendix B is HS-021 605; Appendix C is HS-021 606.
Availability: NTIS

HS-024 504

STAPP CAR CRASH CONFERENCE (22ND) PROCEEDINGS. OCTOBER 24-26, 1978, ANN ARBOR, MICHIGAN

A compilation of 20 papers on the subject of human tolerance in automobile crashes is presented. Topics covered include the following: variation of human tolerance to impact and its effect on the design and testing of automotive impact performance; incidence and severity of cerebral concussion in the Rhesus monkey following sagittal plane angular acceleration; experimental head impacts on cadavers; effect of initial position on the human head and neck response to plus Y impact acceleration; dynamic characteristics of the human spine during -Gx acceleration; sensitivity of porcine thoracic responses and injuries to various frontal sites and a lateral impact site; development of a promising universal thoracic trauma prediction methodology; correlation between thoracic lesions and force values measured at the shoulder of 92 belted occupants involved in real accidents; evaluation of air cushion and belt restraint systems in identical crash situations using dummies and cadavers; comparison of dynamic responses of anthropomorphic test devices and human anatomic specimens in experimental pedestrian impacts; whole-body human surrogate response to three-point harness restraint; bolster impacts to the knee and tibia of human cadavers and an anthropomorphic dummy; injury mechanisms in side impact; means for effective improvement of the three-point seat belt in frontal crashes; subcompact vehicle energy-absorbing steering assembly evaluation; safety performance of asymmetric windshields; first step to a pedestrian safety car; accuracy and usefulness of the Simulation Model of Automobile Collisions;

sled test comparisons of child restraint performance; and protection of child occupants in automobile crashes.

Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pa. 15096
Rept. No. SAE-P-77; 1978; 671p refs
Sponsored by Wayne State Univ; Univ. of California, San Diego; and Univ. of Michigan, Hwy. Safety Res. Inst. Includes HS-024 505--HS-024 524.
Availability: SAE

HS-024 505

THE VARIATION OF HUMAN TOLERANCE TO IMPACT AND ITS EFFECT ON THE DESIGN AND TESTING OF AUTOMOTIVE IMPACT PERFORMANCE

One of the major difficulties in the safety design of motor vehicles is the variability of road accidents. This variability arises in part from the external accident conditions, such as the direction and velocity of impact, and also in part from the variation of the occupant, including such factors as size, weight, location, and impact tolerance. The effect of such variability is to undermine the validity of a "typical accident" approach in which a design is tested at a single speed with a single size dummy and a single injury criterion. Working from a statistical approach, using methods originating from statistical mechanics, a quantitative measure of the injury probability, taken over the whole spectrum of road accidents, is derived. This gives an objective measure of injuries taken over the whole population of car occupants and accident situations, and therefore provides an assessment of the vehicle's impact injury potential which is more closely related to the road situations. A solution of the related optimization problem, i.e. the provision of the optimum force/deflection characteristic (within a given space) to minimize the injuries on the road, is also included.

by J. A. Searle; J. Bethell; G. Baggaley
Motor Industry Res. Assoc., U.K.
Publ: HS-024 504 (SAE-P-77), "Stapp Car Crash Conference (22nd) Proceedings," Warrendale, Pa., 1978 p1-32
Rept. No. SAE-780885; 1978; 12refs
Conference held at Ann Arbor, Mich., 24-26 Oct 1978.
Research sponsored by Dept. of Industry, Mechanical Engineering and Machine Tools Requirements Board (U.K.).
Availability: In HS-024 504

HS-024 506

INCIDENCE AND SEVERITY OF CEREBRAL CONCUSSION IN THE RHESUS MONKEY FOLLOWING SAGITTAL PLANE ANGULAR ACCELERATION

Results are presented of a series of 40 experiments performed on Rhesus monkeys in which the heads were subjected to a controlled, single, approximately sinusoidal pulse of angular acceleration about a fixed axis perpendicular to the sagittal plane. The head was constrained to undergo planar motion with a total angular displacement of 60 degrees in each case. Angular acceleration values ranged up to 1.2×10 to the fifth power rad/sec/sec, and peak values of tangential acceleration at the center of the mass of the brain reached 1300 g's. Physiological and neurological data including EKG, EEG, systemic arterial pressure, intracranial pressure, respiration,

corneal reflex, were recorded. The post insult state was evaluated for each subject in accordance with a scale of Experimental Trauma Severity (ETS) based on the observed changes in the physiological and neurological variables. The ETS scale ranges from 0 (absence of any changes) to 6 (instantaneous death with gross brain fragmentation). The severity of the injury correlated well with the mechanical input in terms of acceleration (angular or tangential) and in particular, with the maximum value of the resultant tangential force (ranging up to 910 Newtons) applied to the brain. The occurrence of subdural hematomas originating in the parasagittal bridging veins in 16 of the experiments is well correlated with peak values of tangential acceleration with onset occurring at values of 700 g's. Results are also given in terms of the incidence of cerebral concussion (occurring in 27 out of the 40 studies) as a function of mechanical variables including angular acceleration, brain mass, and pulse duration. The results display a statistically significant gradation of reversible trauma effects with increasing mechanical input. Subdural hematoma formation appears as a threshold phenomenon, the consequences of which dominate the clinical outcome. The results suggest that the injury cannot be explained by a single kinematic mechanism as proposed by Holbourn, and that possibly large deformation mechanics are required to explain them. It is concluded that the resultant physiological, neurological, behavioral, and pathological changes mimic quite closely those seen after human head injury and that the experiment produces a particularly good model of acute subdural hematoma.

by Jacob M. Abel; Thomas A. Gennarelli; Hiromu Segawa
University of Pennsylvania, Div. of Neurosurgery,
Philadelphia, Pa.
Publ: HS-024 504 (SAE-P-77), "Stapp Car Crash Conference
(22nd) Proceedings," Warrendale, Pa., 1978 p33-53
Rept. No. SAE-780886; 1978; 7refs
Conference held at Ann Arbor, Mich., 24-26 Oct 1978.
Research sponsored by National Inst. of Health, National Inst.
of Neurological and Communicative Disorders and Stroke.
Availability: In HS-024 504

HS-024 507

RESULTS OF EXPERIMENTAL HEAD IMPACTS ON CADAVERS: THE VARIOUS DATA OBTAINED AND THEIR RELATIONS TO SOME MEASURED PHYSICAL PARAMETERS

Results are presented of 42 tests involving direct impact of the head of fresh, unembalmed, perfused cadavers, helmeted or nonhelmeted, by means of a free-fall procedure. Frontal, temporal-parietal, and frontal-facial impacts were investigated. Injection into the circulatory system has proven to be a successful means of detecting cerebral injuries resulting from vascular rupture on fresh cadavers. The experiments resulted in a typology of lesions (associated with various test conditions) that differs from the one described in earlier, similar studies of A. M. Nahum and of R. L. Stalnaker. A high frequency of injury to the brain stem was revealed in the case of cadavers injured, mainly in those falling from three meters. Correlating Abbreviated Injury Scale (AIS) and Head Injury Criterion (HIC) values is difficult because individual tolerances are very scattered; the type of variables raises special problems due to definition of AIS, approximate determination of injury gravity, mathematical definition of HIC, etc., and because the analysis that would provide the means of separating the influence of various parameters available after experiments has not yet been started. These experiments, nevertheless, have made it possible to set a threshold level for the appearance of severe

injuries, without fractures, during temporal-parietal impacts at a HIC of 1500; there is only a slight likelihood of a serious injury occurring for a value of HIC below 1500. This threshold is different from the "tolerance level", which is necessarily higher. For pure frontal impact without fractures, it appears that an acceleration pulse linked to a HIC over 1500, could be supported by the head of a living person (being more tolerant than a cadaver) without severe injury in the majority of cases. More experiments are needed to confirm this result. Impacts that give rise to injury of the facial bones, injuries occurring at lower overall acceleration levels and under conditions of impact for which simulation by Part 572 dummies is unsatisfactory, must be set aside. For experiments the condition of the cranium must be determined because it is possible that the mechanical characteristics of the cranium are linked with cerebral tolerance. A large number of directions and conditions of impact will have to be considered.

by C. Got; A. Patel; A. Fayon; C. Tarriere; G. Walfisch
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Publ: HS-024 504 (SAE-P-77), "Stapp Car Crash Conference
(22nd) Proceedings," Warrendale, Pa., 1978 p55-99
Rept. No. SAE-780887; 1978; 14refs
Conference held at Ann Arbor, Mich., 24-26 Oct 1978.
Research performed in collaboration with Rene Descartes
Univ., Biomedical Res. and Teaching Dept., Paris, and
sponsored by French Thematic Action prog.
Availability: In HS-024 504

HS-024 508

EFFECT OF INITIAL POSITION ON THE HUMAN HEAD AND NECK RESPONSE TO PLUS Y IMPACT ACCELERATION

Results are presented for plus Y impact acceleration experiments on six young adult male volunteers representative of a wide range of anthropometry (18 experiments per subject for a total of 108 experiments) to study the response of the head and neck relative to four initial head positions. The four following initial head positions (relative to the first thoracic vertebral body) were investigated over a range of sled acceleration peaks from 2G to 7G: neck up/chin up, head tilted left, head tilted right, and head down. Lateral bending of the head and neck in the direction of the acceleration-induced motion significantly reduced the resultant peak head angular acceleration and velocity, a result similar to that found in the -X direction. Lateral bending of the head and neck in the direction of the acceleration-induced motion often produced an angular acceleration profile with a deceleration peak greater than the acceleration peak, a result also found in -X impact experiments. Lateral bending of the head and neck in the direction of the acceleration-induced motion increased the linear resultant acceleration at the head anatomical origin. Regression analysis indicated that the roll of the head has a larger but opposite effect to the roll of the neck, so that bending of the head relative to the neck in the direction of the induced motion tends to make the reduction of head angular acceleration and velocity greater. Bending of the head and neck forward (pitch) increased the angular acceleration and velocity. The effects of bending of the head and neck in the direction of the acceleration-induced motion (roll) were greater than for the bending in the opposite direction. The direction of the head angular velocity vector in the head anatomy was in most cases near constant for head and neck roll conditions but departed from this model quite significantly for the initial condition

possible exception of the initial condition where the head and neck were pitched forward significantly, it should be possible to approximate all of the other initial conditions in this study with the same type of fixed-axis model.

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Naval Aerospace Medical Res. Lab. Detachment, New Orleans, La.
Publ: HS-024 504 (SAE-P-77), "Stapp Car Crash Conference (22nd) Proceedings," Warrendale, Pa., 1978 p101-38
Rept. No. SAE-780888; 1978; 11 refs
Conference held at Ann Arbor, Mich., 24-26 Oct 1978.
Research sponsored largely by Naval Medical Res. and Development Command and Office of Naval Res.
Availability: In HS-024 504

HS-024 509

DYNAMIC CHARACTERISTICS OF THE HUMAN THORACIC SPINE DURING -GX ACCELERATION

Initial kinematics and kinetics of human cadaveric specimens subjected to -Gx acceleration are reported along with an attempt to design a surrogate spine for use in an anthropomorphic test device (ATD). There was a total of 30 spines on 9 embalmed and 2 unembalmed cadavers which were heavily instrumented. External photographic targets were attached to T1, T12, and the pelvis to record spinal kinematics. The subjects were restrained by upper and lower leg clamps attached to an impact seat equipped with a six-axis load cell. The total relative rotation of the thoracic spine was generally greater than that of the lumbar spine. However, the flexibility of the two segments defined in terms of an average rotation at each vertebral joint, was comparable for embalmed spines. The unembalmed lumbar spine was more flexible than the thoracic spine, but this conclusion is based on 7 runs and 2 cadaveric subjects. Living human volunteer data will be required to determine whether the embalmed or the unembalmed spinal data are more human-like. Both types of spine lack muscle tone, but the rigidity of the embalmed spine may be able to simulate some muscular action. A design approach for a surrogate spine for an existing ATD was derived using a bar linkage synthesis method. A rigid link 486-mm long and attached along the posterior aspects of the ATD torso is proposed. A complete design requires the incorporation of joint resisting torques and joint stops to simulate the actual motion of T1 relative to the pelvis.

Naveen K. Mital; Richard Cheng; Robert S. Levine; Albert King
Wayne State Univ.
DOT-HS-5-01232
Publ: HS-024 504 (SAE-P-77), "Stapp Car Crash Conference (22nd) Proceedings," Warrendale, Pa., 1978 p139-65
Rept. No. SAE-780889; 1978; 7 refs
Conference held at Ann Arbor, Mich., 24-26 Oct 1978.
Availability: In HS-024 504

HS-024 510

SENSITIVITY OF PORCINE THORACIC RESPONSES TO INJURIES TO VARIOUS FRONTAL AND LATERAL IMPACT SITE

Twelve anesthetized pigs were subjected to various blunt frontal impacts or a right-side impact to assess biomechanical and

thoracic compliance (i.e. sternal acceleration, normalized deflection, blood overpressure, as well as force-deflection characteristics) and injury (i.e. skeletal and visceral trauma, and conduction dysfunction) were significantly affected by the location of the sternal load. Impacts above mid-sternum (to a relatively stiff thorax) produced infrequent skeletal damage but serious mediastinal hemorrhaging and lung laceration; whereas, impacts below mid-sternum (to a more compliant thorax) resulted in extensive skeletal damage and liver laceration. For lateral impacts, large penetration into the rib cage produced serious liver injuries with extensive near-side skeletal damage in one case and no fractures in the other. The evaluation of functional response to impact was enhanced by analysis of potential heart dysfunctions and of variations in blood catecholamines. Disturbances of the myocardial conducting system were observed from multi-lead ECG recordings. Left anterior hemiblock was frequently observed after impacts at or below mid-sternum. The block either resolved or progressed to ventricular fibrillation in several minutes. In an analysis of the induced stress, a transient increase was observed in plasma catecholamine concentrations which was alleviated rapidly within minutes after the impact.

by David C. Viano; Charles Y. Warner; Keith Hoopes; C. Mortenson; R. White; Charles G. Artinian
General Motors Res. Labs., Biomedical Science Dept., Warren, Mich.; Brigham Young Univ., Provo, Utah; St. Joseph Hosp., Dept. of Cardiology, Pontiac, Mich.
Publ: HS-024 504 (SAE-P-77), "Stapp Car Crash Conference (22nd) Proceedings, Warrendale, Pa., 1978 p167-207
Rept. No. SAE-780890; 1978; 33 refs
Conference held at Ann Arbor, Mich., 24-26 Oct 1978.
Availability: In HS-024 504

HS-024 511

DEVELOPMENT OF A PROMISING UNIVERSAL THORACIC TRAUMA PREDICTION METHODOLOGY

Analysis of experimental acceleration time history data obtained from a thoracic instrumentation array has been performed. The data were generated under test conditions which included realistic frontal impacts in belt, air bag, and steering column systems and side impacts with rigid and padded door structures. Data from frontal and lateral pendulum impacts also were included. The results demonstrate that the instrumentation array captures sufficient information from the impact event to allow prediction of resulting thoracic trauma, defined either as thoracic Abbreviated Injury Scale or total number of thoracic fractures, using a single function for each injury measure. Each function is universal in the sense that it is valid for all test modes and directions of impact. A strategy for developing a surrogate thorax to implement this injury predictive methodology is discussed and preliminary specifications are presented.

by Rolf H. Eppinger; Kenneth Augustyn; D. Hurley Robbins
National Hwy. Traffic Safety Administration; Adaptronics, Inc.; University of Michigan, Hwy. Safety Res. Inst.
DOT-HS-4-00921; DOT-HS-6-01365
Publ: HS-024 504 (SAE-P-77), "Stapp Car Crash Conference (22nd) Proceedings," Warrendale, Pa., 1978 p209-68
Rept. No. SAE-780891; 1978; 5 refs
Conference held at Ann Arbor, Mich., 24-26 Oct 1978.
Availability: In HS-024 504

CORRELATION BETWEEN THORACIC LESIONS AND FORCE VALUES MEASURED AT THE SHOULDER OF 92 BELTED OCCUPANTS INVOLVED IN REAL ACCIDENTS

The three-point static seat belts that are installed in Renault and Peugeot cars are equipped with a force limiter near the upper anchorage, and are composed of several bands of materials that tear successively for the increasing levels of force exerted by the wearer. These restraint characteristics were used to study the relationship between the injury level (thoracic AIS (Abbreviated Injury Scale)) and force values (daN (rupturing load)) for 92 belted occupants who were involved in head-on collisions. Crash parameters (velocity change, mean deceleration), and age of occupants were examined. Injury tolerance levels observed in the study sample were compared to thoracic injuries observed on belted cadavers exposed to comparable impact conditions. It was determined that seat belt wearers under the age of 30 can withstand up to 740 daN of shoulder load (corrected in terms of passenger weight) without any chest injuries. For seat belt wearers over the age of 50, rib fractures were observed at a much lower level of load, but this group is rarely involved in the more violent impacts. Too few people from 30 to 50 years of age were subjected to a shoulder load of over 500 daN to establish tolerance curves over the age range. It was concluded that the rating of thoracic injuries by the AIS exaggerates the seriousness of a considerable number of cases; for example, it ascribes an AIS 3 to two rib fractures, the same severity level given to a brain concussion with skull fracture. The underestimation of thorax tolerances of live subjects based on experiments with fresh cadavers was verified. It is felt necessary to set the tolerance threshold fairly high in order to save the greatest number of persons at risk; 59% of car occupants involved in accidents in France in 1975 were under the age of 35 (vs. 17% for 35-45 age group, 13% for 45-55 age group, and 11% for over 55 age group) and were over-represented in the more violent impacts. Still lacking are data needed for establishing the relevance between the thorax responses of live patients and those of cadavers or dummies. Reconstitutions of real-life accidents would help, and would have the additional advantage of subjection to realistic impact conditions, which is not always the case with cadavers, certain of which far exceed the deceleration levels attained in even the most violent real-life accidents.

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EVALUATION OF AIR CUSHION AND BELT RESTRAINT SYSTEMS IN IDENTICAL CRASH SITUATIONS USING DUMMIES AND CADAVERA

An experimental program is discussed which entailed symmetric and one-half offset frontal full-size car-to-car (1973

Chevrolets) crash tests at 60 mph closing speed utilizing fresh cadavers and anthropometric test devices (ATD's) and both belt and air cushion restraint systems. Data obtained included head and chest triaxial accelerations from externally located sensors and thoracic accelerations from implanted sensors on the cadavers, normally measured internal triaxial head and chest accelerations, and femur loads on the ATD's and belt loads for both cadavers and ATD's. Osteologic data allow comparison among cadavers with respect to skeletal quality. It was found that satisfactory levels of protection were provided for the full range of adult occupant size in the frontal symmetric tests. Where comparisons can be made in these symmetric tests, cadaver and ATD results are generally in good agreement. Neither the cadaver nor the ATD results, in these symmetric tests, show any clear indication that either the air cushion restraint system or the belt restraint system was superior or that either produced significantly different results for varying adult occupant size in the 5th female to 50th male size range. For the frontal offset tests, the cadaver results (with one exception out of eight cadavers), based upon radiographic and autopsy studies, indicate that satisfactory levels of protection were provided by both restraint systems. Cadaver and ATD results are not generally in as good agreement for the offset tests as for the symmetric tests. The injury criteria values determined from the cadavers used as human surrogates tend to present a more conservative or critical evaluation of the effectiveness of a restraint system. It is concluded that pre-test osteologic studies always should be performed as part of the selection process to preclude the utilization of low skeletal quality (as was the case for the one cadaver cited earlier as an exception with regard to test results). The results clearly demonstrate that cadaver testing should play a significant role in restraint system design, development, and evaluation. There is need for further data analysis to define better the relationships between the human surrogates used in this type of crash testing and the injury criteria results obtained.

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COMPARISON OF THE DYNAMIC RESPONSES OF ANTHROPOMORPHIC TEST DEVICES AND HUMAN ANATOMIC SPECIMENS IN EXPERIMENTAL PEDESTRIAN IMPACTS

The design specifications for adult and 6-year-old child dummies for use as pedestrian surrogates and subsequent improvements during extensive experimental testing are described, and the dynamic responses of the dummies with those of unembalmed cadaveric specimens in pedestrian impact situations are compared. The dynamic performance of the Part 572 adult dummy, as modified for pedestrian surrogate applications, has been shown to be quite consistent with that of the unembalmed cadaver. A high degree of similarity exists in acceleration levels, physical displacement, and time phasing. This is especially true of the lower body response in which the measured

ble.
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DOT-HS-4-00961
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HS-024 515

WHOLE-BODY HUMAN SURROGATE RESPONSE TO THREE-POINT HARNESS RESTRAINT

A Whole-Body Response (WBR) research program was conducted to generate data on the kinematics and response of human surrogates in a realistic automobile impact environment. The program used a test configuration consisting of an idealized hard seat representation of a car seat with a three-point harness restraint system. The following three different severity levels of crash test conditions were used: low-severity level corresponding to a 25 kph velocity change and 10 G average deceleration, an intermediate-severity level with 32 kph and 10 G, and a high-severity level with 50 kph and 20 G characteristics. The human surrogates tested were 15 male cadavers, a Hybrid II (Part 572) anthropomorphic test device (ATD), and a Hybrid III ATD recently developed by General Motors. In addition, mathematical simulations of the response and kinematics of a 50th percentile male occupant were performed at the three levels of crash severity, using the Motor Vehicle Manufacturers Assoc. Two-Dimensional Crash Victim Simulator. The primary utility of the data generated is for comparing the similarities and differences in response and kinematics of the various types of human surrogates and in pointing out areas that need improvement in both ATD's and mathematical models. It was found during the experimentation that repeated runs on the same cadaver did not invalidate the results of the second run, and that embalming did not significantly affect the response measures. It was concluded that the head-neck response of the tested human surrogates is consistent with the physical construction of the various necks, and that the chest response of both Hybrids II and III, as measured by spinal accelerometers, was in general agreement with that of the cadavers, although the cadaver chest response was more variable and oscillatory, which may be attributed to rib fracture effects and vertebral body motions not present in either dummy. The pelvic response of cadavers had a broader waveform than that of the dummies, but all were in general agreement. Any discrepancies may be the result of differences in the pelvic mass distribution and chest-pelvis linkages. Similar observations may be made about the restraint system loads.

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KNEE BOLSTERS TO THE KNEE AND TIBIA OF HUMAN CADAVERS AND AN ANTHROPOMORPHIC DUMMY

Knee bolsters on the lower instrument panel have been designed to control occupant kinematics during sudden deceleration; however, a wide variability in car occupant anthropometry and choice of seating posture indicates that lower-extremity contacts with the impingement bolster predominantly could load the flexed leg through the knee (acting through the femur) or through the tibia (acting through the knee joint). Potential injuries associated with these types of primary loading may vary significantly and an understanding of potential trauma mechanisms is important for proper occupant restraint. Impacts of the bolster panel against the knee or lower leg were simulated in ten human cadaver and anthropomorphic dummy tests, and the following aspects were assessed: biomechanical response for lower-extremity impacts, potential mechanisms of skeletal and ligamentous trauma, differences between cadavers and dummy response, and knee-joint ligament failure characteristics in isolated knee-joint tests. Knee impacts with a 55.9 kg bolster-covered mass at 6.0 m/sec resulted in frequent avulsion fractures of the posterior cruciate ligament at its osseous attachment to the tibia with peak contact loads of 7.02 kN (7.74 kN peak dummy femur load). Analysis of high-speed movies and radiographs indicated that the bolster loaded against the tibial tuberosity early in the event, translated the tibia posteriorly, and resulted in a stretching of the posterior cruciate ligament. Lower-leg impacts produced tibial/fibular fractures or knee-joint ligament failures with peak bolster contact loads of 5.15 kN (4.21 kN peak dummy femur load). Isolated knee-joint tests indicated complete failure of the ligament after 2.26 cm of relative posterior tibial subluxation and a resistive load of 2.48 kN. However, the absolute values of the maximally tolerated loads may be influenced significantly by the deficiencies of the cadaver model and cannot be extrapolated directly for real-life situations. Since the lower extremity of the dummy cannot accommodate translatory motion at the knee joint and the skeletal mass of the dummy significantly exceeds that of the human, substantial kinematic and biomechanical response differences occurred between tested human cadavers and an anthropomorphic dummy.

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HS-024 517

INJURY MECHANISMS IN SIDE IMPACT

By a comparison of test results for car-to-car side-impact crashes at 40 kph and 50 kph with and without intrusion, it is shown that instrumented dummy occupants seated near the impacted side in which intrusion of the side wall into the passenger compartment has occurred are exposed to the most severe injury. The influence of intrusion on injury severity can

be explained by the speed at which the side wall of the struck car is deformed. The door and the seat frame of the struck car sustain a velocity change higher than the car floor. The pelvis of the dummy seated near the impacted side undergoes a velocity change of the same order of magnitude as that experienced by the car door, whereas the chest has a lower velocity change. The pelvis sustains the highest value of velocity change because it is involved directly in the deformation of the side structure. A high frequency of pelvis and femur injuries is, for the occupants seated near the impacted side, a typical characteristic of side-impact accidents. Stiffening of the car seat and padding of the car door would decrease the severity of injuries sustained by occupants seated near the impacted side in such collisions. A better knowledge of human tolerance to side impact is needed to determine the padding's mechanical characteristics.

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HS-024 518

MEANS FOR EFFECTIVE IMPROVEMENT OF THE THREE-POINT SEAT BELT IN FRONTAL CRASHES

Current design of seat belt systems may not provide sufficient protection for the car occupant. Using basic criteria of favorable biomechanical restraint, various means for effective improvements of a conventional three-point retractor seat belt system are discussed. A simple redesign of a conventional car seat is proposed, and sled tests compare it with a conventional seat. The effect of reducing belt slack using a crash-activated belt tightener, and eliminating the excessive outlet of webbing from the retractor reel using a webbing-locking device is studied for both seats. A seat belt system with optimized restraining performance is proposed. This can be achieved by redesigning the seat, fitting an energy-absorbing cushion for improved restraint of the pelvis; introducing a webbing-locking B-pillar loop, eliminating the excessive outlet of webbing; and introducing an automatic crash-activated belt tightener to reduce excessive belt slack. Benefits of the new system include increased biomechanical quality of the seat belt restraint system, with favorable load geometry and low risk of submarining; significantly lower head deceleration, Head Injury Criterion reduction by about two-thirds, with reduced risk of head and neck injuries; significantly lower chest deceleration, Severity Index reduction by about one-third, with smaller chest compression and reduced risk belt-induced chest injuries; significantly reduced vertical chest deceleration with much smaller longitudinal load on the spinal column; and reduced head excursion which, in combination with the reduced head deceleration level, produces reduced risk of head impact injuries. The seat design improvements reduced head and chest decelerations and minimized vertical motion of the pelvis. The introduction of a sliding anchorage for the seat belt buckle helped control this vertical motion. Satisfactory performance was obtained also by replacing the sliding anchorage with a vertical arrangement of the lap belt. Head excursion was reduced by the webbing-locking B-pillar loop which eliminated the elongation of the shoulder belt due to the "film-spool" retractor effect. The belt tightener improved overall restraining

performance with reduced head and chest deceleration. However, the level of improvement depends on the magnitude of the initial belt slack. Normally, considerably larger belt slack can be expected in the field than in the laboratory, due to incorrectly adjusted belts and heavy clothing.

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HS-024 519

SUBCOMPACT VEHICLE ENERGY-ABSORBING STEERING ASSEMBLY EVALUATION

Results of a two-year study into the field accident performances of two basic designs of energy-absorbing steering assemblies are described. The two basic designs are the axial collapse type of steering column used in conjunction with shear capsule, and the self-aligning energy-absorbing steering wheel mounted on a nonstroking column. Major injury causation factors for these types of steering assemblies were identified, based on an analysis of 161 accident cases selected for unrestrained drivers in frontal accidents in two different vehicle types (Chevrolet Vega and Ford Capri (and Escort subcompacts). Compartment collapse was found to be statistically significant in relation to occupant injury for the first data source, the Multidisciplinary Accident Investigation teams (independent of the contribution of change of velocity). It suggests that an actual vehicle crash test might be more appropriate for evaluating the safety potential of a steering assembly than a sled test. It is possible that compartment collapse is so important that it may eliminate the effect of benefit from steering column axial collapse or that it may alter the design of the column to prevent it from working properly. For the second data source (accident cases collected by researchers at Univ. of Birmingham, England), with the convoluted can behind the steering wheel, compartment collapse as measured by floor deformation was found to be statistically significant with respect to occupant injury. Analysis of the data indicated that the variable steering wheel rim damage (SWRD) is significantly related to occupant injury. The SWRD may be an indicator of steering column involvement. For slight SWRD, more axial-collapse column cars (Vegas) were observed than the convoluted can cars (Capris). For severe SWRD, more Capris were involved. This phenomenon may be the result of the failure of the Capri convoluted can stroke when necessary, the SWRD thus becoming more severe. For the Vega, significant column stroke usually was associated with high SWRD, possibly indicating problems with the column stroke or more serious collisions for which injury would have been more severe without the column. The restrained-rear-passenger-behind-the-driver variable was correlated strongly with occupant injury. The change in velocity

the case vehicle strongly related to injury, the higher the change, the higher the injury, all other things being equal.

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HS-024 520

SAFETY PERFORMANCE OF ASYMMETRIC WINDSHIELDS

A comparative study of the safety performance of asymmetric and standard High Penetration Resistant windshields was conducted, and the effect of increased interlayer thickness was evaluated. Four types of asymmetric windshields were tested with the following respective inner layer, interlayer, and outer layer thicknesses (mm): 1.5, 0.76, and 2.5; 1.5, 1.14, and 2.5; 1.1, 1.14, and 2.5; and 0.8, 0.76, and 2.5. The experimental program consisted of both full-scale sled tests and headform drop tests. A total of 127 vehicular impacts were carried out using a modified Volkswagen Rabbit. The test subject was a 50th percentile Part 572 anthropomorphic test device. The asymmetric windshields were found to have a lower lacerative potential than that of the standard windshield (2.5 mm, 0.76 mm, and 2.5 mm). The best Triplex Laceration Index (TLI) value of 5.2 was provided by a 0.8 mm, 0.76 mm windshield at 60 kph, compared to a TLI of 7.7 for the standard windshield. All Head Injury Criterion (HIC) values were less than 1000 at 48 kph. The drop tests were designed to study head injury potential at velocities below 30 kph at which the windshield may not fracture. The HIC value for the standard windshield was found to be as high as 800 without fracture. Tempering of such windshields can increase the hazard. Nonfractured asymmetric windshields did not exhibit dangerous HIC values.

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HS-024 521

FIRST STEP TO A PEDESTRIAN SAFETY CAR

The front end (bumper, hood, fender and hood/windshield junction) of an Opel Ascona was modified by lowering the bumper and using foam, in order to reduce the potential for pedestrian injury. Comparative testing of this modified vehicle and the standard factory model was conducted using child and adult dummies as pedestrians by impacting laterally at speeds of 25 kph and 45 kph. Triple axial measurements of accelerations were made for head, chest, and pelvis of adults, and for head and chest of children. Results show that it is possible to lessen the dangers of automobile front ends in car-pedestrian accidents by the use of foam padding. The peak accelerations were reduced by 60 G for the child's chest and 40 G for an

adult pelvis at 45 kph. No measurements were made for the child pelvis. No effect was found on the adult chest due to the modification. Mean loading on the adult head was approximately equal for the modified and standard cars; the effect of the foam was negated by a change in impact point. Specific results showed that head impact for adults was tolerable up to 45 kph; that the head impact point was closer to the vehicle front; and that the head impact point for the child was still too hard. Lowering of the bumper lessens the loading of the extremities. There is considerable scattering of values for secondary (street) impact due to varying impact conditions. Street impact is slightly less with respect to head impact; the adult pelvis, however, accelerates more. Further improvements are possible by "deadening" the foam to make it more plastic, and by designing a special front end not limited by the standard configuration.

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HS-024 522

THE ACCURACY AND USEFULNESS OF SMAC [SIMULATION MODEL OF AUTOMOBILE COLLISIONS]

Some of the limitations and strengths of accident reconstruction simulations, with illustrations and emphasis drawn from the SMAC (Simulation Model of Automobile Collisions) program, are discussed. In particular, some coarse physical approximations used and some coding errors incurred in the formulation of SMAC are considered, together with their respective effects on the accuracy of prediction. Revisions of the basic SMAC coding have been developed to overcome these shortcomings. Results of uncorrected and revised SMAC simulations are demonstrated by comparison with the physical theory. The correction of inherent problems of overestimation and unwarranted oversimplification of tire force calculations should improve materially the fidelity of the SMAC program to its theoretical potential. The recent SMAC revision, termed T/SMAC, has demonstrated significant advancements in application of an improved representation of the crush layer for narrow, hard object impacts, while exhibiting some of the same limitations and errors as the basic N/SMAC program. Software for other corrections and refinements suggested by special cases are under development. SMAC is an objective tool for research, as are most numerical computer techniques, only to the extent that it produces faithfully the same results when supplied a given set of inputs. N/SMAC has been shown to be consistently, objectively, wrong in some aspects. True objectivity in a reconstruction/simulation must include objective input data, an acknowledgement of the uncertainty that always exists in measuring quantities, and a careful analysis of the physical meaning of each model parameter. When users can be truly objective about its abilities and inputs, and when its code is caused to conform more closely in some respects to

physical reality SMAC will yield simulations that are both accurate (within determined limits) and objective.

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HS-024 523

SLED TEST COMPARISONS OF CHILD RESTRAINT PERFORMANCE

Results are presented of 75 sled tests to evaluate the performance of various child restraint systems in frontal and lateral crash situations. In addition to the tests with the standard trapezoidal sled pulse shapes and child restraints installed with adult lap belts and top tether straps simulating center rear-seat installations, tests were conducted with acceleration pulses of a triangular waveform, acceleration pulses that more closely represent the crash signatures of large and small cars, top tethers intentionally not installed, a child restraint in the center front-seat installation, and a child restraint installed using an emergency locking retractor in a bucket seat with no top tether attachment. Two types of three-year-old size anthropometric test devices were used. Data obtained include head excursion, head and chest triaxial accelerations, and Head Severity Index and Chest Severity Index values. Reference is made to Federal Motor Vehicle Safety Standard No. 213 and Canadian P.C. 1977-1013 dynamic performance criteria. It is concluded that there is a need for investigation of the effects of sled pulse waveforms with respect to acceleration (deceleration) onset, peak acceleration levels attained, velocity change, and pulse time. In addition to the requirement for a "standard bench seat" as a stable, repeatable platform for child restraint testing, there is a need for a "standard child restraint" to define the optimum sled pulse for evaluation of child restraint effectiveness. Most current child restraints, to be effective in 30-mph frontal collisions, require the proper installation and use of a top tether. Submarining, as well as head excursion, should be considered in any regulation or standard concerning child occupant protection. Regulations and standards for child restraint testing should include lateral impact response criteria. Since some types of child restraint exhibit high rebound accelerations, Head Injury Criterion values should be calculated over a time period that includes rebound.

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HS-024 524

PROTECTION OF CHILD OCCUPANTS IN AUTOMOBILE CRASHES

Detailed investigations were conducted of automobile crashes in which children under 10 years of age were passengers in

order to study the injury patterns of restrained and unrestrained child occupants and to assess the performance of child restraint systems in real-world crashes. A total of 348 vehicle crashes involving 494 children which occurred mainly in Washtenaw and Oakland counties of Michigan were identified; 48 crashes involving 63 children were selected for in-depth study. Of the children studied, 37% were restrained by an adult lap belt or a child restraint; only 4.7% of the children in the overall sample were restrained, and only 33% of all the child restraint systems were installed according to manufacturers specifications. The use of both adult seat belts and child restraints was found to be effective in reducing injuries in crashes. The incorrect use of the restraint systems contributed to an increased injury potential for child occupants. The potential for head contact still remained with lap belt systems. Head and facial injuries were found to be the most common forms of child injury, and the most common sources of these injuries were the instrument panel and the back of the front seat. Federal Motor Vehicle Safety Standard (FMVSS) 201 should be modified to include child occupant protection; many of the interior surfaces that may not be impacted very frequently by adult heads and faces can be impacted by those of children; FMVSS 201 is based on the use of adult-size oriented test procedures. The lack of severe crashes in which child restraint systems were being used properly at the time of the crash has precluded the assessment of the upper limits of protection provided by such systems. Fifteen case summaries (vehicle, type of crash, weather and road conditions, accident description, details of vehicle deformation, restraint system performance, subject child injury summary) of investigated crashes with restrained children are appended.

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HS-024 525

EMERGENCY VEHICLE WARNING LIGHTS: STATE OF THE ART

Information is presented concerning many aspects of emergency vehicle warning lights (EVWL's). A survey of the present situation includes the nonuniformity of state EVWL laws, the factors entering into the choice of an EVWL configuration, and a list and photographs of a variety of EVWL devices. Background material relating to the perception of EVWL signals includes an analysis of general warning signal perception, a description of the visual stimulus pattern confronting a driver being approached by an emergency vehicle from various directions, and a summary of the characteristics of peripheral vision (including luminous efficiency, color perception and discrimination, and flicker and movement perception). Perceptual factors affecting the conspicuity of EVWL signals are discussed, including number and spatial pattern of lights, cross-sectional area, motion, temporal phase relations, and the role of the background. Physical measurements on EVWL units are described, including angular intensity distribution and beams spread, flash rate, pulse shape and flash duration, effective intensity, color, and variables in rotating devices. A gloss-

sary is provided, extensive enough to be helpful in reading the technical literature.

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National Bureau of Standards, Washington, D.C. 20234
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Sponsored by National Inst. of Law Enforcement and Criminal Justice. Law Enforcement Equipment Technology Rept.
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HS-024 526

VEHICLE ENTRAPMENT. FINAL REPORT [STOPPING OUT-OF-CONTROL CARS BY GRAVEL ARRESTOR BEDS]

Results are presented of a study to develop a gravel arrestor bed configuration that would stop and entrap out-of-control automobiles within 100 ft, with minimized resultant injury to the occupants and minimal damage to the vehicle. Details are provided of the test track, vehicle control and guidance systems, and the construction, maintenance, and restoration of the various gravel-bed configurations after impact. Eight configurations were tested using 3/8" (1 cm) washed pea gravel. Of the level beds one featured a tapered transition, gradually increasing depth from zero depth at the beginning of the bed, increasing to 1 ft (.3 m) in depth at 45 ft (13.7 m) into the bed and remaining uniform at this depth for the remainder of the bed; another was of uniform depth (a 1 ft uniform depth of gravel with the top of the bed being at ground level). A tapered bed was constructed on top of the uniform depth bed with the height of the gravel above ground level being zero at the beginning of the bed and increasing at a rate of 1 ft per 100 ft (30.5 m) in bed length. Pile beds were constructed of uniform height, a series of transverse piles of uniform height, each pile in the form of a windrow perpendicular to the direction of travel. These included beds of three different pile heights (1 ft, 1 1/2 ft (.46 m), and 2 ft (.6 m)), a tapered pile (the first 25 ft (7.6 m) of the bed with 1 ft high piles, the middle 24 ft (7.3 m) with 1 1/2 ft high piles, and the last 100 ft with 2 ft high piles), and a 1 1/2 ft uniform height pile at 25 degrees angle as measured from the head-on direction. Of all the bed configurations tested, the 1 1/2 ft pile bed of uniform height was judged the best design to accommodate a 55 mph (88.5 kph) impact. This was determined after analyzing the resultant stopping distance, average vehicle deceleration, and vehicle damage data for all beds tested. Although the 2 ft high pile bed stopped the test vehicle in a shorter distance than the bed with 1 1/2 ft high piles, damage to the vehicle was somewhat severe and the peak deceleration forces much greater. Level-bed configurations required approximately 50% to 200% more stopping distance at the same speed than the 1 1/2 ft high pile bed.

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New Jersey Dept. of Transportation, Bureau of Structures, Materials, and Applied Mechanics Res., 1035 Parkway Ave., Trenton, N.J. 08625
N.J.-HPR-PL-1(11)-Study-7701
Rept. No. FHWA-NJ-RD-76-008-7701; 1976; 62p 3refs
Prepared in cooperation with Federal Hwy. Administration.
Availability: Corporate author

HS-024 527

STATISTICS ON SCHOOL TRANSPORTATION, 1976-77, BASED ON REPORTS FROM STATE DEPARTMENT OF EDUCATION [U.S.]

For each state, the following data on pupil transportation during the 1976-1977 school year are tabulated: number of enrolled pupils transported at public expense, total number of buses, number of vehicles used (Type I, Type II, public ownership, private ownership), and expenditure of public funds for transportation including capital outlay. Modified data are also presented for Manitoba, Canada. A table provides data indicating the growth of school transportation in the U.S., including the following information for each school year, starting with 1954-1955 and ending with 1976-1977: number of pupils transported, number of vehicles used, and expenditure.

National Assoc. of State Directors of Pupil Transportation Services
1978?; 4p
Cover title: Statistics on Pupil Transportation, 1976-77.
Availability: Corporate author

HS-024 528

ROAD ACCIDENT EMERGENCY RESPONSE SYSTEM: A LITERATURE REVIEW

The emergency medical response system in the handling of traffic accident casualties is reviewed through the literature, including such main elements as communications, transportation, equipment, and personnel. Emergency medical services (EMS)* in operation in the U.S., Canada, Australia, Europe, and the U.S.S.R. are reviewed in comparison with services available in South Africa. Particular emphasis is placed on the aspects of upgrading the skills of personnel in treating traffic-related injuries, and the training necessary to keep up with modern techniques of patient resuscitation and stabilization. The ambulance vehicle, equipment, and response time capability are discussed, and ambulance alternatives, such as the helicopter, are reviewed. The attitudes of medical personnel involved in emergency services are considered. It is concluded that EMS systems are well organized in some communities, mediocre in others, and nonexistent in many. Training of personnel represents the greatest shortcoming in EMS systems. The provision of emergency services in rural areas seems an insurmountable problem requiring a concerted effort to overcome. A centralized, hospital-based service has some advantages over a decentralized fire department-based system in a high-density urban environment. Communications should be centralized, with full-time, trained personnel. Where the helicopter ambulance really can be justified is in rural or small communities, where long distance and rough terrain are confronted. The low frequency of casualties in rural areas, however, makes this type of service prohibitively expensive, unless the service is shared by the local police, fire department, city, etc., with a priority rating for medical services. Education of the public in first-aid methods and methods of reporting accidents could be pursued more vigorously. Cooperation and liaison with the military to supply more aid in rural areas could be pursued more actively. Salaries and fringe benefits for emergency medical technicians or paramedics should be in-

creased, commensurate with qualifications, and efforts made to attract promising candidates for the profession.

by W. N. Van Kralingen

National Inst. for Transport and Road Res. South Africa
(Nasionale Instituut vir Vervoer- en Padnavorsing Suid-Afrika), P.O. Box 395, Pretoria, South Africa 0001
Rept. No. RU/14/76; 1976; 64p 91refs
Sponsored by National Road Safety Council (South Africa).
Availability: Corporate author

HS-024 529

AUTOMOBILE WINDSCREEN [WINDSHIELD] GLASS: A REVIEW OF OVERSEAS STUDIES AND THEIR RELEVANCE TO THE RSA [REPUBLIC OF SOUTH AFRICA]

After a brief outline of the historical development of the three types of glass used in automobile windshields (High Penetration Resistant (HPR) laminated glass with a plastic interlayer of 0.76-mm thickness, old type laminated glass with a plastic interlayer of 0.38-mm thickness, and tempered or toughened glass), relevant information is presented from foreign studies of the injury potential of automobile windshield glass. In South Africa, the Uniform Road Traffic Ordinance specifies that all glass in motor vehicles be safety glass, defined as "transparent glass or other transparent material so constructed or treated that, when fractured, the possibility of large flying fragments or sharp splinters is minimized". Presently, all three types of glass are used in car windshields. From the data presented, it is considered that there can be no doubt that the HPR 0.76-mm laminated windshield is far superior to the old 0.36-mm laminated windshield with regard to injury potential and is far superior to the tempered windshield with regard to injury potential and convenience of replacement. The cost-benefit argument in Europe against the use of HPR laminated glass is not applicable to South Africa. When replacement factors and effects on the national economy are taken into consideration, there appears to be little or no cost advantages in fitting a tempered windshield vs. an HPR laminated windshield. Compulsory wearing of seat belts will not solve the problem of windshield injury potential. Rear-seat occupants, middle front-seat occupants, and occupants of vehicles over 2500 kg in weight, as well as pedestrians, are liable to be injured by windshields. It is recommended strongly that the relevant legislation in South Africa be amended to ensure that the only glass used for motor vehicle windshields in the future be HPR 0.76-mm laminated safety glass.

by G. Kinsey

National Inst. for Transport and Road Res. South Africa
(Nasionale Instituut vir Vervoer- en Padnavorsing Suid-Afrika), P.O. Box 395, Pretoria, South Africa 0001
Rept. No. RV/4/77; 1977; 28p 24refs
Includes Afrikaans summary.
Availability: Corporate author

HS-024 530

AN ASSESSMENT OF THE MOTOR CYCLE ACCIDENT PROBLEM IN SOUTH AFRICA

Motorcycle traffic accident statistics and motorcycle usage, education, and legislation for South Africa are analyzed in comparison with those of other countries (European countries, Japan, Australia, U.S., Canada) in an effort to determine fac-

tors that contribute to motorcycle accidents and to make recommendations to improve motorcycle traffic safety. The number of licensed motorcycles in South Africa has increased by 39% from 1961 to 1974. In Jun 1974, there were 110,333 licensed motorcycles representing 3.6% of the total licensed motor vehicles in South Africa. Motorcycle accidents and casualties have been decreasing from 1970 to 1974. In 1974, there were 3019 motorcycle accident casualties of which 108 died. Motorcycle accident characteristics for South Africa are very similar to those in most other countries, young white males riding in urban areas during daylight being most frequently involved. Because of this similarity, most of the foreign research findings related to motorcycle safety are applicable to South Africa. The two main factors in accident causation are lack of training and education of motorcyclists in the safe operation of their vehicles, and the lack of daytime conspicuity. Further research is recommended in these areas.

by W. H. J. Sator

National Inst. for Transport and Road Res. South Africa
(Nasionale Instituut vir Vervoer- en Padnavorsing Suid-Afrika), P.O. Box 395, Pretoria, South Africa 0001
Rept. No. RV/1/76; 1976; 48p 20refs
Availability: Corporate author

HS-024 531

ROAD TRAFFIC ACCIDENTS AND CASUALTIES FOR THE REPUBLIC OF SOUTH AFRICA: 1975

Traffic accident statistics for South Africa in 1975 are tabulated as follows: all accidents by geographical area (urban/rural) and severity (fatal, major, minor, no injury); casualties by area and severity (killed, seriously injured, slightly injured); and casualties by area, type of vehicle (car, truck, bus, motorcycle, bicycle, other vehicle, pedestrian) and race (white, non-white). Drivers involved in injury accidents were tabulated by type of vehicle, area, and race; drivers involved in injury accidents by age and race (white, Bantu, Asiatic, colored); pedestrians involved in accidents by age and race; and bicyclist casualties by age and race. Violations of drivers were tabulated by severity of accident and condition of driver (had not been drinking, not known if had been drinking, had been drinking (by age group), and not applicable). Drivers involved in injury accidents were tabulated by race and by vehicle defects (defective brakes, defective tires, defective steering, no vehicle lights, defective headlights, other, no defects, unknown). Injury accidents were tabulated by type of vehicle; by area and month; by area and day of week; by area, two-hour periods, and day of week; by area, road layout, and visibility; and by area and road surface. Overall, there were 260,762 accidents involving 76,717 casualties of which 8001 died.

by J. Bron

National Inst. for Transport and Road Res. South Africa
(Nasionale Instituut vir Vervoer- en Padnavorsing Suid-Afrika), P.O. Box 395, Pretoria, South Africa 0001
Rept. No. RY/13/76; 1976; 21p
Availability: Corporate author

June 29, 1979

HS-024 535

HS-024 532

REGISTRATION MARK SYSTEMS FOR MOTOR VEHICLES [LICENSE PLATES]

A review of alphanumeric systems used on motor vehicle license plates in various countries is presented, with a view to devising an optimum system for South Africa. Specifications for license plates are outlined. Attention is concentrated on the road safety and law enforcement aspects of license plate systems, with limited consideration given to motor vehicle administration, and fitting of plates to vehicles. Extensive efforts have been made in Europe in recent decades to standardize registration plates; these attempts have covered all aspects, including positioning, dimensions, colors, reflectorization, arrangement and composition of characters, and dimensions, design, and spacing of characters. Some success has been achieved but not in the area of the alphanumeric systems themselves (i.e. the arrangement and composition of characters). The fact that no uniform system is likely to be adopted internationally in the foreseeable future provides South Africa with the opportunity to select a revised license plate system. It is suggested that the license plate's function in South Africa should be limited to providing the information necessary for fast and accurate identification of a vehicle for administrative and law enforcement purposes. The alphanumeric system should consist of not more than six characters, including not more than three letters; it should incorporate an initial geographical area identification; it need not incorporate vehicle class or age identifications; and it should have sufficient capacity to assign unique marks to the ten million vehicles predicted for South Africa in the year 2000. A more efficient motor vehicle licensing system would be possible in South Africa if vehicle registration were to be centralized or computerized or both.

by G. L. Dehlen
National Inst. for Road Res. South Africa (Nasionale Padnavorsingsinstituut Suid-Afrika)
Rept. No. RV/1/73; 1973; 29p 14refs
Sponsored by National Road Safety Council (South Africa).
Availability: National Inst. for Transport and Road Res., P.O. Box 395, Pretoria, South Africa 0001

HS-024 533

A PROCEDURE FOR SETTING OBJECTIVES IN ROAD SAFETY

A systematic approach for the setting of national road safety objectives is outlined, with particular reference to South Africa. The first two steps consist of an analysis of the existing road traffic and accident conditions, using reliable statistics, and a survey of all organizations responsible for road safety, including their interrelationships. Decisions must then be made on major goals, after consideration of constraints imposed by other society goals, and of criteria for evaluating various alternative solutions. A possible major goal could be the minimization of road accident deaths, which could be assessed in terms of the cost of safety measures per life saved. The next step is to generate several possible alternative national safety objectives, e.g. to reduce the annual number of road fatalities to N per million vehicle km within M years. The final steps consist of listing alternative potential measures, an analysis of these measures, selection of an op-

timum blend of promising measures, and deciding on the most suitable objective.

by G. L. Dehlen
National Inst. for Road Res. South Africa (Nasionale Padnavorsingsinstituut Suid-Afrika)
Rept. No. RY/2/74; 1974; 22p 21refs
Sponsored by South African road authorities, and National Road Safety Council.
Availability: National Inst. for Transport and Road Res., P.O. Box 395, Pretoria, South Africa 0001

HS-024 534

SPEED TRENDS ON TRANSVAAL RURAL ROADS: 1966-73 [SOUTH AFRICA]

Motor-vehicle speed distribution data are tabulated from measurements taken annually at various sites (10 sites from 1966 to 1970, 13 sites from 1970 through 1973) on major rural roads, including two freeways after 1969, in the Transvaal, South Africa. Speed distributions are compared in terms of average speeds, the percentage of light motor vehicles exceeding 130 kph, the percentage of heavy motor vehicles in the traffic, and the speeds below which 10%, 20%, 30%, 40%, 50%, 60%, 70%, and 85% of the vehicles were traveling. The Friedman analysis of variance of ranks was used to compare the observations in different years. Average speeds of light motor vehicles increased on the average by about 0.86 kph per year, according to a linear regression analysis, while 85th percentile speeds increased by about 1.46 kph annually. For heavy motor vehicles, the corresponding increases were 1.07 kph and 1.25 kph. Proportionately more motorists exceeded 130 kph in 1973 than in 1966, and the percentage of heavy vehicles in traffic fluctuated significantly, but unsteadily, from year to year. The average 85th percentile and mean speeds of light motor vehicles in 1966, the year before imposition of a general 70 mph speed limit for rural areas, were not significantly out of line with trends observed in later years.

by B. E. Fernie; A. J. Lentz
National Inst. for Transport and Road Res., Pretoria, South Africa
Rept. No. RY/3/74; 1974; 46p
Sponsored by South African road authorities, and National Road Safety Council.
Availability: National Inst. for Transport and Road Res., P.O. Box 395, Pretoria, South Africa 0001

HS-024 535

DETERMINATION OF ROAD TRAFFIC ACCIDENT PRIORITY AREAS IN THE REPUBLIC OF SOUTH AFRICA

As the first part of a project to analyze the South African road safety system in order to determine road safety priority areas and countermeasures, the scope of the overall project is defined and a method for determining priority areas is formulated. Based on ideological considerations, constraints imposed by available data, and basic characteristics of countermeasures themselves, "possible priority areas" (i.e. specific road user groups from which priorities will be selected) are considered to consist of three distinct categories of reduction: number of accidents, number of casualties, and number of people killed. A particular road user group is considered for priority if it has a higher than average risk of being involved in an accident, becoming a casualty, or of being killed. Preliminary calcula-

tions using 1971 accident data indicate that the following road user groups should receive priority: accident reduction (buses, motorcycles, cars, and commercial vehicles, accounting for 69% of total accidents); casualty reduction, including severity of injury (motorcyclists and passengers, car occupants, and commercial vehicle occupants, accounting for about 59% of total casualties); and fatality reduction (motorcyclists and passengers, car occupants, and commercial vehicle occupants, accounting for 78% of fatalities to vehicle users and 44% of all traffic fatalities). It is shown that South Africa has a disproportionately high number of fatalities, the reduction of which possibly could be accomplished by postcrash measures (e.g. first aid to accident victims, and improvement of emergency services). Additional road safety countermeasures on a national level should be concentrated in the following areas: primary safety measures (e.g. improvements in vehicle handling characteristics, vehicle maintenance, and driver capability and accident avoidance behavior); secondary safety measures (e.g. improvements in vehicle equipment, and changes in user behavior to reduce incidence of casualties once an accident has occurred); and postcrash measures (e.g. improvements in vehicle equipment for greater passenger protection).

by C. S. Roebuck

National Inst. for Transport and Road Res. South Africa
(Nasionale Instituut vir Vervoer- en Padnavorsing Suid-Afrika), P.O. Box 395, Pretoria, South Africa 0001
Rept. No. RY/12/76; 1976; 52p 16refs
Availability: Corporate author

HS-024 536

BICYCLE AND MOPED ACCIDENTS 1968. PARTIAL REPORT 2, MOPED ACCIDENTS (CYKEL- OCH MOPEDOLYCKOR 1968. DELRAPPORT 2 MOPEDOLYCKOR) [SWEDEN]

Statistics are presented for police-reported traffic accidents occurring in Sweden in 1968 which directly involved mopeds and which resulted in injuries. Accidents are classified by area (urban or rural); by time (month, day of week, and time of day); by light conditions (daylight, twilight, darkness); by road condition (dry, wet, ice or snow, unknown); and by sex and age of moped drivers. Other classifications included traffic elements involved (moped alone, moped/motor vehicle, moped/moped, moped/bicycle, moped/pedestrian, moped/other traffic elements), exceptional circumstances which contributed to the accident, and degree of accident severity. Of 2097 accidents studied, 359 were considered to be of a specific nature (caused by exceptional circumstances). Of the remaining 1738 accidents, 76% took place in urban areas, 72% occurred from April to September, and most in daylight and on dry roads. Of the moped drivers involved, 91% were men and 8% were women (sic). About 44% of the moped drivers were in the 15- to 17-year-old age group. The overwhelming majority of the accidents, 1325 or 76%, were caused by a collision between a moped and another motor vehicle, 85% of these occurring at intersections. Of the 359 accidents treated separately, 98 involved drivers who committed a traffic offense (73 moped drivers, 25 other drivers), and the other 261 involved drivers who were impaired or had defective vehicles. The most common cause of impairment was alcohol use; the most common vehicle defect was defective brakes. In the accidents investigated, 110 moped drivers were killed and 581 suffered serious injuries, while 1270 received slight injuries. The most effective measure for preventing moped accidents is to separate moped and other motor vehicle traffic, i.e. construc-

tion of special paths for mopeds (and bicycles) with intersections between these and other roads on different levels. The accomplishment of such a measure on a 100% basis is not possible within the foreseeable future. Other countermeasures include instructing moped drivers how to behave in various traffic situations and educating motorists to leave sufficient room for mopedists, the use of red flags extending from the rear of the moped, the addition of moped turn signals, and prevention of modifications to moped engines.

by L.-B. Kritiz; H. Mohlin; B. Olsson

Statens trafiksakerhetsrad, arbetsgrupp TRAG, Stockholm, Sweden

Rept. No. STR-174; 1971; 115p 5refs

Translated from Swedish (original 63p; translation 52p).

Availability: Reference copy only

HS-024 537

ENVIRONMENTAL INTERRELATIONS OF THE DRIVER-VEHICLE-ROAD COURSE CONTROL LOOP (DIE UMWELTBEZIEHUNGEN DES SPUREGELKREISES FAHRER-FAHRZEUG-STRASSE)

Mathematical analysis of the driver-vehicle-road system demonstrates that on a very slippery road, even a most alert and accurately responding driver requires a wider lane to safely avoid roadway obstacles than under normal environmental conditions. Optimum driver response to such adverse conditions requires exact knowledge of vehicle behavior under the changed conditions (i.e. limitations in vehicle traction and stability) and adaptation to the adverse road conditions by more precise reactions. For the inexperienced driver, a reduction in speed is the primary adaptation possibility. In order for this group of drivers to safely avoid an obstacle, they must realize in advance the traction limitations of the roadway while deceleration is still possible.

by Klaus Niemann

Publ: ATZ Automobiltechnische Zeitschrift v80 n6 p277-9 (1978)

1978; 10p 3refs

Translated from German (original 3p; translation 6p).

Availability: Reference copy only

HS-024 538

QUALITY CONTROL OF TIRES, PT. 2 (SICHERUNG DER QUALITÄT VON REIFEN)

Quality control in the manufacture of automobile tires as an integrated system from planning phase through observation in the marketplace is discussed in this second of two articles. Six main groups of tire quality characteristics (relative to road ways clear of ice and snow) are considered. These are driving comfort, steering behavior, driving stability, driving safety, durability, and economy. These groups are subdivided into various subgroups; a list of from 60 to 100 quality characteristics can be compiled by which the quality of any tire can be described in a quantitative and reproducible manner. Quality planning involves the development of a new tire or modification of an existing design beginning with the establishment of quality goals which involve meeting statutory provisions and the requirements of the automobile manufacturer. Quality control in the development stage is examined; prototypes and test specimens are fabricated in the laboratory or in limited

production runs in the development stage. When the test tires satisfy rating requirements, tires are produced in a pilot run using mass-production techniques according to the same specifications; in this step, special attention is given to those properties which depend largely on the manufacturing process. Series quality control is explained as being performed only to a minor extent on the finished product, purely from a cost point of view. The most important series quality control activities involve the production process. The finished product can satisfy rating requirements only if the quality of the structural components (correspondence of structural components with the specified material and design data), raw materials (correspondence of delivered commodities with specifications), and machinery and processes (correspondence with production regulations) are guaranteed beforehand. This does not preclude, however, a detailed final inspection of each tire before delivery and a monitoring of the current series by road and machine tests in accordance with an established random sampling plan.

by Rainer Stark; Siegfried Nebe
 Publ: ATZ Automobiltechnische Zeitschrift v80 n6 p283-8 (1978)
 1978; 13p
 Translated from German (original 4p; translation 8p).
 Availability: Reference copy only

HS-024 539

PINPOINT HARDENING BY ELECTRON BEAM [STEEL AND CAST-IRON AUTOMOTIVE PARTS, HEAT TREATING]

Speed of operation, minimum distortion of parts, miserly use of energy, and adaptability to production lines are among the important reasons why the new electron-beam (EB) selective-area heat treating method of surface hardening of steel and cast-iron parts already has been accepted in high-production automotive plants. The EB system is faster than laser hardening, more accurate than induction hardening, more selective than flame hardening, and far more energy-efficient than all three processes. The EB system is costly, nevertheless. Complete with vacuum pumping system and work chamber, either a beam programmer or a minicomputer control for precision beam placement, and interface hardware and software, a turnkey EB system costs from \$200,000 to \$250,000. The heart of the system is an EB gun whose principal elements are a hot cathode filament that emits electrons, an anode that accelerates them, a focus coil that concentrates the electrons at a controlled distance from the gun, and a deflection coil that directs the beam of electrons in the pattern programmed into the control system. In some systems, both the gun and the workpiece are contained in a vacuum or partial-vacuum enclosure; others operate with the workpiece in an inert-gas atmosphere. When the EB gun is energized, it emits a stream of electrons which impinge on the surface of the workpiece. The electrons give up their kinetic energy in colliding with the atoms of the metal, and the temperature of the surface reaches the austenitizing range in less than a second. Penetration depth depends on the beam power applied by the gun and on the duration of exposure to the beam. Examples of parts that can be selectively hardened by the EB system with machine-tool accuracy are clutch cams, valve lifters, pushrod ends, and a variety of spindles and shafts. Typically, a

hardened case, 0.030 in deep, can be developed in a cast-steel part in about a second.

by Donald R. Dreger
 Publ: Machine Design v50 n24 p89-93 (26 Oct 1978)
 1978
 Availability: See publication

HS-024 540

GEARS PUT MUSCLE IN HYDROSTATIC DRIVES

Hydrostatic drives are compact, flexible, and easily controlled, but their size is strongly influenced by current limitations on hydraulic pressure. For continuous duty, commercially-available piston hydrostatic drives are limited to about 5000 psi and vane drives to about 2000 psi. These pressure limits mean that high-torque drives are too large for many vehicle applications. Combined hydrostatic and planetary transmissions, or "combined drives", offer the best potential for minimizing cost and weight in applications requiring 20,000 lb-ft or more of torque. For example, a currently-available piston motor has a maximum torque capability of about 64,000 lb-ft, and weighs approximately 4760 lb. By contrast, a much smaller piston motor combined with a 165:1 planetary gearbox provides almost 64,000 lb-ft of torque, but weighs only 1000 lb and costs much less than the high-torque motor. Higher continuous-duty pressures would help reduce this size difference, but probably would not change the cost difference greatly. Few geared hydrostatic drives are available in pre-engineered packages, but reliable combinations are easy to design if one starts at the load and then works back to the hydraulic motor. The basic technique for selecting a combined hydrostatic and planetary drive is to determine the required output capacity of the drive, pick a gearbox that can supply that capacity, and choose a hydrostatic drive with a motor that can power the load reflected through the gearbox. Examples of possible applications of combination drives include jack-up boats used in offshore drilling operations, mining vehicles, and windrowers for farming.

by Howard J. Sculthorpe; Robert Lemon
 Publ: Machine Design v50 n24 p101-5 (26 Oct 1978)
 1978
 Availability: See publication

HS-024 541

FIELD DEPENDENCE AND DRIVER VISUAL SEARCH BEHAVIOR

Two studies were conducted to examine the relationship between field dependence (extent to which a person is capable of overcoming an embedding context in order to perceive relevant targets) and on-the-road visual search behavior. In the first study, concerned with driver eye movements in curve negotiation, it was found that field-dependent subjects have a less effective visual search pattern. In the second study, young and aged drivers were compared on several information processing tasks and on their ability to maintain their eyes closed part of the time while driving. Of the various information processing tasks, only field dependence and visual search time correlated significantly with the mean time the drivers needed to maintain their eyes open while driving. Together the two studies indicate that field-dependent subjects require more time to process the available visual information and are less effective in their visual search pattern. Given the current

philosophy of licensing drivers on the basis of performance of tasks that are directly driving-related (e.g. knowledge, vision, driving), it is unlikely that any test of cognitive style could be used for screening purposes. On the other hand, since performance in the Embedded Figure Test (which measures field dependence) has been shown to be consistent within subject and different among subjects, it is likely that training programs may be differentially effective for field-dependent subjects, though it remains an open question as to whether this group actually can modify their visual search behavior accordingly. The fact that a systematic change in the visual behavior of novice drivers has been observed at different periods of training suggests that this aspect of driver behavior may be amenable to training and may be highly cost-effective.

by David Shinar; Edward D. McDowell; Nick J. Rackoff;
Thomas H. Rockwell

DOT-HS-115-3-772

Publ: Human Factors v20 n5 p553-9 (Oct 1978)

1978; 16refs

Sponsored in part by Federal Hwy. Administration, and Ohio Dept. of Transportation.

Availability: See publication

HS-024 542

VISUAL TARGET ACQUISITION AND OCULAR SCANNING PERFORMANCE

The effects of information and physical variables on human visual search performance and on the ocular activity associated with that performance were investigated. Three experiments were completed using a brief exposure technique. In the first experiment, the performance data were analyzed in terms of search speed, movement speed, response accuracy, post-acquisition processing speed, and dwell speed. In the second and third experiments, the variables analyzed were mean percent correct, mean search time, mean movement time, mean fixation rate during stimulus, and mean fixation rate on cluster positions during stimulus. The manipulated variables included memory load, exposure duration, and the physical grouping of information within a display. Several patterns emerged from the data. Stimulus information appeared to have no effect on eye movement measures. Instead, the physical restrictions imposed on the search task were responsible for changes in ocular behavior. The per item search rate increased as the total information in the display increased. This information effect supports the variable processing rate hypothesis, i.e. the greater the processing demands, the higher the search rate.

by John B. Mocharnuk

Publ: Human Factors v20 n5 p611-31 (Oct 1978)

1978; 29refs

Based on doctoral dissertation, New Mexico State Univ.

Availability: See publication

HS-024 543

PERIPHERAL ACUITY AND PHOTOINTERPRETATION PERFORMANCE

Previous human visual task studies have shown a relationship between measures of peripheral acuity and performance in searching for artificial targets. The present study applied these findings to real targets in aerial photography, using trained image interpreters. Correlations between field size and search performance ranged from 0.619 to 0.920. Significant increases

in field size resulted from repeated testing but not, on an overall basis, from training. A measure of peripheral field size appears to provide a useful tool for selecting photointerpreters; the benefits of field expansion training remain somewhat in question.

by Jon C. Leachtenauer

Publ: Human Factors v20 n5 p537-51 (Oct 1978)

1978; 16refs

Availability: See publication

HS-024 544

THE EFFECT OF AREA, DENSITY, AND NUMBER OF BACKGROUND CHARACTERS ON VISUAL SEARCH

In a visual search task (locating a particular target at an unknown position in the visual field), the area of search field, the density of background characters, and the number of background characters are not independent. Many researchers have found increases in search times with each of these factors but have not adequately controlled all three together. In this experiment, eight subjects were tested on a set of search fields covering combinations of all three variables. Search time was found to depend most heavily on number of background characters, but there were significant effects due to the other two variables. For a constant number of background characters, search time was found to decrease as density increased. Direct visual lobe measurements confirmed these findings, which could have importance in visual inspection tasks.

by Colin G. Drury; Matthew R. Clement

Publ: Human Factors v20 n5 p597-602 (Oct 1978)

1978; 20refs

Availability: See publication

HS-024 545

'79 POWERTRAINS [U.S. PASSENGER CARS]

New powertrain features of 1979 model year passenger cars are described for General Motors Corp., Ford Motor Co., Chrysler Corp., and American Motors Corp. For 1979, the U.S. auto manufacturers have concentrated on refinements which have resulted in increased mileage, reduced emissions, and improved driveability. Diesel, turbocharged, and V-6 engines have become more available, while electronic engine monitoring has become more sophisticated. Most electronic monitoring is relegated to California applications, providing valuable testing before future installation on 49-state versions. Because of the Corporate Average Fuel Economy (CAFE) regulations, 1979 powertrain improvements have been geared predominantly to improve fuel efficiency. General Motors has taken the biggest step by offering two completely new, smaller engines. Ford and Chrysler have concentrated on electronic engine controls which offer the possibility of making current powertrains conform to future regulations. American Motors was far enough ahead of fuel efficiency requirements to preclude massive retooling, and worked on improving driveability and economy. CAFE and Environmental Protection Agency regulations will become more stringent in the 1980's and the limited application of electronic engine systems for California cars will then find widespread usage.

Publ: Automotive Industries v158 n14 p81-7 (Oct 1978)

1978

Availability: See publication

HS-024 546

PLANETARY WHEEL DRIVE POWERS AGRICULTURAL VEHICLES

The design of the Borg-Warner Power Wheel Drive and its application to hydrostatic agricultural vehicles are described. As hydrostatic drive systems for agricultural equipment gained in popularity, a means became necessary for efficiently transmitting the high-speed, low-torque output of the hydraulic motor to the low-speed, high-torque wheel output required for vehicle operation. Although the advantages of the hydrostatic transmission over the conventional drivetrain had been realized, the final (open) chain-and-sprocket drive retained its inherent disadvantages. An efficient, cost-effective means of transmitting the hydrostatic transmission's output to the vehicle wheel was needed, without the disadvantages of the chain and sprocket. Also required was a convenient means of disconnecting the power source from the vehicle wheel for towing the vehicle over the highway between work areas. These features are provided by the Borg-Warner Power Wheel Drive, a highly-efficient, two-stage compound planetary gear set composed of seven subassemblies (input shaft and coupling, disconnect cover, primary and secondary planetary assemblies, ring gear, hub and bearings, and spindle). The planetary wheel drive improves the hydrostatic drive system by providing flexibility in locating final drive, elimination of alignment and clearance considerations, increased safety, and ease of maintenance.

by James D. Wiggins
Borg-Warner Corp., Warner Gear Div.
Rept. No. SAE-770761; 1977; 19p 4refs
Presented at Off-Highway Vehicle Meeting and Exhibition,
Milwaukee, 12-15 Sep 1977.
Availability: SAE

HS-024 547

A LIGHT RAIL VEHICLE NAMED DESIRE [STREETCARS]

From the perspective of the San Francisco Municipal Railway's new Boeing-Vertol Light Rail Vehicle (LRV), the history of the streetcar or trolley is traced, indicating that perhaps the streetcar functions best as a symbol of what was best, what barely remains, and what again may become a standard mode of travel. The first horse-drawn streetcar was put into service in Paris in 1819, when the first lasting public transit system was organized. In 1831, New York City chartered the first streetcar company in the New World, and in time every city had some form of horse-drawn public transit. By 1890, there were 28,000 such streetcars over 5700 mi of city tracks. In 1888, the first electric streetcar of the mode that exists today, a car with one or more electric motors and an overhead pickup, was put into service in Richmond, Va. A year later, 200 lines were either in service or were being built. City street railways grew enormously from 1902 to 1917; at the end of the period, there were 80,000 trolleys. By the depression, trolleys were in decline. World War II's shortages brought them back briefly, but after that it was downhill until today. Two partisan schools of thought exist about how automobiles and buses brought about the disappearance of the electric streetcar. One attributes the death of trolleys to natural economic causes; the other contends that trolleys were wiped out deliberately by the automobile interests, particularly General Motors. Today, much of the rest of the world is expanding existing trolley lines and modifying them into light rail systems. Light rail may

cost as little as half the amount of a full rapid transit system, and may be later converted to rapid transit. In some Western European cities, the placing of trolleys on center medians and rights-of-way, and in tunnels, has resulted in a faster (13 mph to 16 mph average), more comfortable ride than that of buses or automobiles. In contrast, diesel buses have been rejected in a number of European cities. Although diesel buses are less expensive than a light rail network, they ultimately cost more to maintain and emit 15 to 60 times the amount of particulate matter emitted by gasoline engines. U.S. cities are far behind those in Western Europe with respect to public transportation because of grossly inadequate financing and lack of highly-qualified personnel in management and technical areas.

by Alec Dubro
Publ: Mother Jones v3 n9 p14, 18-9 (Nov 1978)
1978; 3refs
Availability: See publication

HS-024 548

CHARACTERIZATION OF DIESEL CRANKCASE EMISSIONS

Methods for measurement and expression of crankcase or "blowby" emissions from diesels were first developed and demonstrated on a test engine and then used to characterize gas and particulate emissions from two in-service engines. Crankcase emissions were evaluated under engine operating conditions corresponding to the Environmental Protection Agency 13-mode certification test. Although crankcase particulate matter seems very close to lubricating oil in composition (e.g. boiling range between 40% and 90% points, and elemental analysis), enough differences exist to indicate that such particles are not simply droplets which have been removed from the oil mechanically. Reasons for this conclusion are the differences between particulate matter and oil in boiling range under the 40% point and differences in calcium content. Since crankcase gas flows are much smaller than intake air flows, most crankcase gaseous and particulate emissions rates are very small compared to corresponding exhaust emissions. Crankcase particulate matter can be sized with apparent accuracy by an inertial impactor, but deposition on surfaces other than collection disks seems to limit use of the device for particle mass flow computations. Crankcase particulate matter seems to be concentrated less toward the small-particle end of the size distribution than diesel exhaust particulate matter. No nitrosamines or precursors were found in crankcase or engine intake air samples. Further research should be performed to qualify and employ the most accurate possible nitrosamine methodology for both sampling and analysis of diesel crankcase gases. Systems for control of diesel crankcase emissions are not yet in widespread use, and data should be acquired on performance and durability effects of such systems.

by Charles T. Hare; Thomas M. Baines
Southwest Res. Inst.; Environmental Protection Agency
EPA-68-03-2196
Rept. No. SAE-770719; 1977; 16p 8refs
Presented at Off-Highway Vehicle Meeting and Exhibition,
Milwaukee, 12-15 Sep 1977.
Availability: SAE

HS-024 549

A NEW GENERATION OF BRUSHLESS CHARGING SYSTEMS FOR FCIM [FARM, CONSTRUCTION, AND INDUSTRIAL MACHINERY] EQUIPMENT

A new generation of brushless, one-wire charging systems is being developed to meet the wide range of requirements of FCIM (farm, construction, and industrial machinery) equipment. The design features of two air-cooled generators which will be available shortly for FCIM equipment are examined in terms of how they meet mechanical durability, environmental protection, reliability, serviceability, electrical capacity, and physical size requirements. A hinge-mounted, belt-driven, oil-cooled generator is also examined in terms of meeting these basic machine requirements.

by W. S. Liston; L. J. Raver
General Motors Corp., Delco-Remy Div.
Rept. No. SAE-770725; 1977; 12p
Presented at Off-Highway Vehicle Meeting and Exhibition,
Milwaukee, 12-15 Sep 1977.
Availability: SAE

HS-024 550

APPLICATION OF MAINTENANCE-FREE BATTERY DESIGN TO FARM, CONSTRUCTION, AND INDUSTRIAL MACHINERY

The characteristics of a modern lead-calcium battery design ("maintenance-free"), offering significant advantages in vehicle design, manufacturing, and usage, are outlined and the benefits considered for many types of vehicles. This type of battery offers excellent storage properties and resistance to vibration and shock, requires no owner attention or service during its useful plate life, eliminates battery acid attack on terminals or battery retainer, and significantly reduces routine service costs. While application in construction machinery has been somewhat limited to date, the battery has been proven for heavy-duty usage in related industries, and several farm equipment manufacturers have switched to the modern lead-calcium design. Analysis of the requirements, coupled with field experience and wide acceptance in related applications, clearly indicate the maintenance-free lead-calcium battery eventually will replace traditional batteries in the farm, construction, and industrial machinery industry.

by N. R. Eisenhut
General Motors Corp., Delco-Remy Div.
Rept. No. SAE-770726; 1977; 11p 7refs
Presented at Off-Highway Vehicle Meeting and Exhibition,
Milwaukee, 12-15 Sep 1977.
Availability: SAE

HS-024 551

THE SYSTEMS APPROACH TO APPLICATION OF GENERATORS, CRANKING MOTORS, AND BATTERIES

Applications of electrical component systems for charging and cranking, designed to function synergistically on FCIM (farm, construction, and industrial machinery) vehicles are discussed. These systems include the generator, regulator, cranking motor, control circuit, battery, wiring harness, and charge indicator. The systems approach follows the principle that

adequate cold cranking performance and generator charging performance depend on all members of this electrical system; performance of the system depends not only on the design of the components, but also upon proper selection and application to the particular engine, plus compliance with manufacturer's recommendations in the field. The cost of the FCIM vehicle dictates complete reliability of the entire vehicle, including the electrical equipment. This reliability can be achieved only by the use of heavy-duty components of required size, performance, and design life. Highway line-haul tractor field testing shows that additional advantages can be obtained by application of the generator, cranking motor, and batteries as a system with an aim toward synergy. The systems approach, with precise techniques of application, promises the completion of this aim.

by G. R. Renner
General Motors Corp., Delco-Remy Div.
Rept. No. SAE-770727; 1977; 12p 8refs
Presented at Off-Highway Vehicle Meeting and Exhibition,
Milwaukee, 12-15 Sep 1977.
Availability: SAE

HS-024 552

SELF-REGULATION OF THE SNOWMOBILE INDUSTRY

The activities of the Snowmobile Safety and Certification Com., Inc. (SSCC), a self-regulated mechanism formed in 1974 as a safety arm by the snowmobile industry, are described. The SSCC is a nonprofit membership (individuals and groups, private and public) association organized to promote, foster, and encourage by lawful means the safe, enjoyable opportunities for snowmobiling through operator safety training and education programs; development of safe trails, use areas, and facilities; and development of voluntary snowmobile machine safety standards. Through its analysis of accident statistics, the SSCC decided that operator training and education offer great potential for achieving significant reductions in the number of snowmobile-related injuries. Efforts to promote operator education include preparing and distributing training literature, and administering the SSCC certification program which involves the review and certification of youthful snowmobile operator safety training programs submitted by states and provinces in the snowbelt. The trails program has involved the preparation of a document which details the means to organize, fund, design, and maintain a trail system; and outlines assistance provided at the state and provincial level to user groups working with legislators and government administrators on trail funding and land use. The SSCC machine standards, constantly being reviewed and improved, set performance requirements for seats, throttle controls, brake controls, the emergency control, brake system, fuel system, shields and guards, electrical and lighting system, reflectors, handgrips, and general hazard and emergency-start requirements. Since SSCC/1, the first version of the standard, was published in Oct 1974, 13 revisions have been approved. Four proposed revisions are under examination, including measures to ensure constant operator control of the vehicle's speed, and the development of probes to determine further the adequacy of shields and guards. A manufacturer participating in the SSCC program must certify every model he makes except those for competition racing. The SSCC label is affixed to the product when it is certified as meeting SSCC standards. An indepen-

June 29, 1979

HS-024 556

dent, third-party (U.S. Testing Co.) certification process is utilized to ensure compliance.

by Roy W. Muth
Snowmobile Safety and Certification Com., Inc.
Rept. No. SAE-770728; 1977; 8p 3refs
Presented at Off-Highway Vehicle Meeting and Exhibition,
Milwaukee, 12-15 Sep 1977.
Availability: SAE

HS-024 553

OPTIMIZATION OF HYDRAULIC SYSTEMS WITH CARTRIDGE VALVES

The effort required to develop an optimum, integrated hydraulic circuit using cartridge valves is summarized and the advantages of such an approach are outlined. The following questions are addressed: why a designer should use cartridge valves, when to consider integrating a hydraulic system, why a designer should integrate a hydraulic circuit, and what information should be transmitted to the vendor when specifying an integrated valve. An integrated circuit valve package can give the system designer a compact valve circuit with minimum potential leak points. The system can be further improved by using cartridge valves for all functions. Any part of the system can now be serviced without removal from the equipment. This can be a savings for both the original equipment builder and the end user. Operating features achieved by using an integrated valve package in a cable reel system in mining operations are outlined. An optimum combination of cartridge valves in an integrated circuit will provide system energy conservation, cost control, reduced installation labor, reduced field maintenance, and reduced down time.

by Frank L. Foster
Snap-Tite, Inc.
Rept. No. SAE-770732; 1977; 7p
Presented at Off-Highway Vehicle Meeting and Exhibition,
Milwaukee, 12-15 Sep 1977.
Availability: SAE

HS-024 554

AGRICULTURAL TRACTOR QUICK DISCONNECT COUPLINGS--PRESENT AND FUTURE

An illustration is given of how a spool-type, quick-disconnect coupling concept can overcome the limitations of present agricultural tractor couplings. Limitations of present couplings include difficulty in connecting and disconnecting under various pressure conditions, flow check-off, lever operation, high spillage, high pressure drop and/or special mating halves. The spool-type coupling design overcomes these problems by using a two-position, balanced spool to permit connecting and disconnecting under all hydraulic pressure conditions up to relief pressure, and a pressure-compensated valve to maintain valve position. Low pressure drop is obtained by proper flow passage design.

by Ken Koch
Gould Inc., Fluid Components Div.
Rept. No. SAE-770733; 1977; 7p
Presented at Off-Highway Vehicle Meeting and Exhibition,
Milwaukee, 12-15 Sep 1977.
Availability: SAE

HS-024 555

HYDROSTATIC DRIVES IN AGRICULTURAL HARVESTING EQUIPMENT

The design benefits are outlined for the conversion from mechanical to hydrostatic drive for both primary and secondary drive systems on a high-production cotton picker. The design criteria for the harvesting machine are presented, as well as a detailed explanation of the hydraulic circuit used to meet the criteria. The most important changes accompanying the conversion to a hydrostatic drive are the elimination of various cross shafts to drive the picker head and the elimination of the differential and axle assembly used for the main propel. This allowed the designer to lower the machine center of gravity, thus increasing machine stability, and to synchronize the picker speed with machine speed more easily. Use of hydraulic or electrical controls, rather than mechanical, makes the machine easier to operate, reducing driver fatigue.

by Dennis Buuck
Fairfield Mfg. Co., Inc.
Rept. No. SAE-770762; 1977; 10p
Presented at Off-Highway Vehicle Meeting and Exhibition,
Milwaukee, 12-15 Sep 1977.
Availability: SAE

HS-024 556

SOLENOID OPERATED CARTRIDGE VALVES

Latest developments in and applications of solenoid-operated cartridge valves used in oil hydraulic systems are reviewed. Flexibility in utilization and ease of maintenance and replacement make cartridge valves desirable in hydraulic systems. Solenoid-operated cartridge valves are relatively small and have limited coil force. These valves are used to control flow of their rated capacity, pilot operate larger directional control valves, produce multiple-pressure function in conjunction with relief valves, produce digital variable flow with pressure-compensated flow-control valves, and other special applications. A line of solenoid-operated two-way, two-position cartridge directional control valves has been developed in conjunction with a series of solenoid coils with different terminations. The coils are completely interchangeable with any of the valves. Additional development in solenoid-operated cartridge valves has resulted in a co-axial solenoid cartridge relief valve which also can utilize the same solenoid coils as the other valves. Among the benefits of solenoid-operated cartridge valves are easy replacement in manifolds, cylinders and/or pumps without disturbing hydraulic lines, to allow ease of maintenance and minimized downtime. Solenoid coil assemblies are similarly replaceable on the control valve, and are interchangeable with the line of valves, permitting flexibility in system design.

by Wayland A. Tenkku
Fluid Controls, Inc.
Rept. No. SAE-770734; 1977; 11p
Presented at Off-Highway Vehicle Meeting and Exhibition,
Milwaukee, 12-15 Sep 1977.
Availability: SAE

INTEGRATION OF COMPONENT DESIGN FOR A 170 TON OFF-HIGHWAY TRUCK

An explanation is given of the design of the components of the Euclid 170-ton capacity, off-highway rear-dump truck, the unique aspects of which are a box-section frame construction, liquid-spring suspension, and horizontal body-size stiffeners. Since overall vehicle performance and durability are dependent on the interrelationship of the major components, particular emphasis is given to an examination of the relationships among the suspension, frame, and body. The vehicular characteristics indicated that the suspension system with liquid springs, while yielding a good ride, also played an important role in minimizing frame and body distress. Liquid springs, or liquid ride struts, have the advantages of predictability, performance, durability, simplicity, ease of maintenance, and economy in structure. There is also a safety feature, since even if a strut fails, the fluid expansion is minimal. Good suspension is also the result of proper geometrical orientation afforded by the frame design. Major design parameters for the frame are durability, lightweight construction, simplicity in manufacture, overall vehicle serviceability, and efficient relationship among components. Related to the simplicity in body design is the capability for variable volume afforded by a simple top rail extension. Loading and haulage qualities were seen to be dependent not only upon the body containing the load, but also upon the suspension which absorbed the input shocks and the frame supporting both body and load.

by Manny H. Naft
Euclid Inc.
Rept. No. SAE-770741; 1977; 12p 3refs
Presented at Off-Highway Vehicle Meeting and Exhibition,
Milwaukee, 12-15 Sep 1977.
Availability: SAE

THE EFFECT OF FIRE RESISTANT HYDRAULIC FLUIDS ON TAPERED ROLLER BEARING FATIGUE LIFE

Fatigue life testing was performed on tapered roller bearings using fire-resistant hydraulic fluids. These included an ester-oil blend, synthetic esters, invert emulsions, and water glycols. Comparison tests were run on a reference petroleum oil and a petroleum-type antiwear hydraulic oil of similar viscosities. Compared to the reference oil, the relative bearing fatigue life was over 100% for the ester-oil blend, 49% to 80% for the synthetic esters, 31% to 53% for the invert emulsions, and 14% to 24% for the water glycols. The fatigue life performance of any specific fluid appears to be related to its chemical structure and its associated effect on fatigue crack propagation. Some fluids exhibited deterioration in their physical properties which could hinder their performance in a hydraulic system. One synthetic ester (S2), a nonphosphate type, was not shear stable and showed a viscosity reduction of one full International Standards Organization viscosity grade. All three invert emulsions tested showed excess water loss and corresponding variations in the viscosity.

by David V. Culp; Ronald L. Widner
Timken Co.
Rept. No. SAE-770748; 1977; 10p 11refs
Presented at Off-Highway Vehicle Meeting and Exhibition,
Milwaukee, 12-15 Sep 1977.
Availability: SAE

DEVELOPMENT OF A VARIABLE SPEED TRANSMISSION FOR LIGHT TRACTORS

From concept to final prototype design, the chronological development and performance characteristics of a variable-speed traction transmission for lawn and garden tractors are described in detail. The transmission is a planetary traction drive utilizing smooth rolling elements coupled to a regenerative planetary gear set. This arrangement produces infinite speed variations to both full forward and full reverse ratios. Special traction fluids are used. Transmission ratio control is unusually smooth and operation quiet under all load conditions. The transmission has automatic ratio control so that under severe loading, ratio is automatically adjusted to the output torque. Illustrations are provided for various lawn and garden tractor applications.

by Thorn W. Dickinson
Textron Inc., Fafnir Bearing Div.
Rept. No. SAE-770749; 1977; 8p
Presented at Off-Highway Vehicle Meeting and Exhibition,
Milwaukee, 12-15 Sep 1977.
Availability: SAE

AIR-COOLED VS LIQUID-COOLED TRANSMISSION OIL COOLER FOR HEAVY-DUTY VEHICLES

Theoretical investigation and computer simulation are presented of the heat-transfer and air-resistance characteristics of three typical transmission cooling system arrangements for automobiles equipped with liquid-cooled engines. One liquid-cooled and two air-cooled cooling schemes were compared. In the air-cooled systems, one transmission oil cooler was placed directly behind the engine, and the other in parallel with the engine, both in the cooling air flow. It was found that an air-cooled system was superior to its liquid-cooled counterpart, when the engine core size and fan power requirement were considered as the principal evaluation criteria. It was determined that the air-cooled scheme, with the transmission oil cooler placed right behind the engine radiator in the cooling air flow path, would be most suitable for heavy-duty vehicles. Computer simulation confirmed the latter finding.

by J. P. Chiou
University of Detroit
Rept. No. SAE-770750; 1977; 20p 15refs
Presented at Off-Highway Vehicle Meeting and Exhibition,
Milwaukee, 12-15 Sep 1977.
Availability: SAE

ELECTRONIC CONTROL SYSTEMS FOR MOBILE HYDROSTATICS

Just as the hydrostatic transmission itself has opened the door to increased flexibility and capability of off-highway drive systems, the electronic control system is the key to fully realizing the unlimited potential of the hydrostatic. Two key factors that will determine the growth rate of the electronic controls market are designing a control package that will perform the desired functions reliably in a hostile environment, and developing reliable, low-cost interface devices to allow the electronic system to interact effectively with the physical vehi-

cle system. Cost effectiveness for the electronic part of the system is a realistic goal today. The greatest improvement in cost effectiveness is needed in interface components. One such interface device has already been developed to meet the need for a good, low-cost transmission control valve. The on-off electro-hydraulic controller (EHC) interfaces electrical control logic with hydrostatic pump and motor displacement. Two completely electronic control systems utilize the EHC as the control interface. The first is a simple, open-loop remote transmission ratio control system. The second is a closed-loop output speed control system with manual and automatic shut-down logic and displays to keep the driver informed of operating conditions. These two systems illustrate cost-effective performance by original equipment manufacture production systems that is possible only with systems of the electronic/hydrostatic type.

by Charles R. Cornell
Eaton Corp.
Rept. No. SAE-770751; 1977; 10p 2refs
Presented at Off-Highway Vehicle Meeting and Exhibition,
Milwaukee, 12-15 Sep 1977.
Availability: SAE

HS-024 562

MULTI-VARIABLE CONTROL FOR ENGINE TRANSMISSION SYSTEMS WITH INFINITELY VARIABLE RATIOS

Results are presented of investigations of two advanced transmission schemes for trucks and buses involving fully-floating epicyclic gear trains. The research was part of an extensive experimental and theoretical research program aimed at the possibility of achieving truly stepless characteristics with very large torque back-up down to output shaft stall. The systems are the Differential Compound Engine (DCE) and the shunt-hydrostatic transmission coupled to a turbocharged diesel engine. The two systems are similar in many basic concepts and operating characteristics, such as the power flow paths through the fully-floating epicyclic gearbox, torque and power envelopes, and overall efficiency contours. In both schemes operational flexibility and scope for optimization are enhanced by the following variable geometry features: fuel pump metering valve or governor set point, turbine nozzle angle (DCE) or hydrostatic motor swash, and engine bypass (DCE) or hydrostatic pump swash. The units are thus controlled by three input variables which may be adjusted independently within certain limits over a wide range of settings, for any demanded output shaft torque and speed combination. These multivariable control schemes, operating in either open or closed loop mode, will probably be accepted as standard heavy-vehicle equipment. In both units, optimization of overall efficiency by these control systems will improve performance by over 10%.

by F. J. Wallace; G. Winkler; D. E. Bowns
University of Bath, Dept. of Engineering, England
Rept. No. SAE-770752; 1977; 14p 12refs
Presented at Off-Highway Vehicle Meeting and Exhibition,
Milwaukee, 12-15 Sep 1977.
Availability: SAE

HS-024 563

HIGH OUTPUT DIESEL ENGINE DESIGN PHILOSOPHY

The rationale is presented for increasing the specific output (brake mean effective pressure) as the most attractive way to provide increased power capability of the diesel engine, and some of the requirements for advanced technology to develop future increased-output diesel engines are reviewed. Data obtained from the Deere 400 series engines are used to support the high-output diesel engine design philosophy. The primary benefits of increasing the specific output to obtain increased power capability are reduced specific cost, weight, and volume of the product; maximum utilization of the manufacturer's capital resources; and reduced energy consumption in the manufacture and operation of the product. Disadvantages of this design include increased thermal and mechanical loading, rapid fall-off of torque reserve below half speed, increased nitrogen oxide emissions, and increased engine noise levels. These durability and performance problems are expected to yield to advancing technology.

by Bob Murphy; Gordon Wright
John Deere Product Engineering Center, Advanced Engines Dept.
Rept. No. SAE-770755; 1977; 8p 10refs
Presented at Off-Highway Vehicle Meeting and Exhibition,
Milwaukee, 12-15 Sep 1977.
Availability: SAE

HS-024 564

VERY HIGH OUTPUT DIESEL ENGINES--A CRITICAL COMPARISON OF TWO STAGE TURBOCHARGED, HYPERBAR, AND DIFFERENTIAL COMPOUND ENGINES

Computer predictions for both steady-state and transient performance of three alternative solutions for higher output diesel engines are presented. The three schemes, all of which have run at least in prototype form, are the two-stage turbocharged diesel engine, the Hyperbar engine, and the Differential Compound Engine (DCE). The two-stage turbocharged engine is the unit closest to current practice and undoubtedly displays the best efficiency characteristics. Both the Hyperbar and DCE represent advanced solutions for even higher output schemes, both at the expense of efficiency. The DCE has the advantage of continuous torque rise down to stall and a greatly simplified transmission, as well as a significant efficiency advantage in the low-speed, low brake-mean-effective-pressure operating region.

by F. J. Wallace; G. Winkler
University of Bath, England
Rept. No. SAE-770756; 1977; 18p 14refs
Presented at Off-Highway Vehicle Meeting and Exhibition,
Milwaukee, 12-15 Sep 1977.
Availability: SAE

HS-024 565

ENERGY USAGE AND OTHER COMPARISONS BETWEEN GASOLINE AND DIESEL MEDIUM DUTY TRUCKS

Fuel consumption and other operating data on equal numbers of comparable diesel and gasoline trucks (1972 model year)

have been compiled from the records of the Maine Dept. of Transportation. The trucks, from the Maine highway maintenance fleet, have a gross vehicle weight of approximately 24,000 lb. The data are for a four-year operating period from 1972 through 1976. The mpg was found to be approximately 1/3 more for the diesel units than the gasoline units. Engine oil required was approximately 20% more for the diesel units, primarily due to the larger crankcase capacity for the diesel trucks. Total fuel, engine oil, and grease costs for the diesel units were approximately 40% less than for gasoline units. Fuel economy of vehicles appeared to be affected by climate and terrain and only minimally by age (miles operated). Reliability of the diesel engine was found to be significantly better than for the gasoline engines. Maintenance (parts and labor for engine and non-engine parts) was found to be slightly less for the diesels than for the gasoline units. Overall, the data seem to indicate an economic advantage with the diesel trucks.

by Kenneth M. Jacobs
Maine Dept. of Transportation
Rept. No. SAE-770757; 1977; 8p 2refs
Presented at Off-Highway Vehicle Meeting and Exhibition,
Milwaukee, 12-15 Sep 1977. Research sponsored by
Transportation Systems Center.
Availability: SAE

HS-802 563

TRAINING PROGRAM FOR OPERATION OF EMERGENCY VEHICLES. COURSE GUIDE

Guidelines are presented for those individuals who will organize and administer the Emergency Vehicle Operation (EVO) Course developed to prepare emergency vehicle (EV) drivers to operate their vehicles safely in the emergency and non-emergency mode. Based on the similarity of knowledge required for the operation of any EV, the course is divided into three parts: basic knowledge (for all EV operators), specialized knowledge (police service, ambulance/rescue service, and fire service units), and skill development (in-vehicle practice). This course guide contains a description of the objectives and scope of the course, covers course planning considerations, and details the special requirements for the in-vehicle range exercises. A final section provides guidelines for monitoring and evaluating the course. For the first two parts of the course, an instructor/trainee ratio of 1:15 is acceptable; for the third part, a ratio of 1:3 is required. The basic knowledge part can be administered by one instructor, whose capabilities and background will depend to some extent on the trainees but who may be an instructor with a background in any of the major emergency services. The instructor for the specialized knowledge part must have a background in the subject to be taught. The classroom instructors from the first two parts of the course may or may not be one of the range instructors. In any case, several range instructors will be required to maintain the desired ratio of one in-vehicle instructor for every three trainees. It is preferable for new range instructors to receive guidance and training from experienced instructors before they teach the program themselves. Several academies and driving schools, as well as National Hwy. Traffic Safety Administration Instructor Training Institutes, are qualified to certify instructors. Any individual from an authorized emergency service who possesses a valid driver's license for the class of vehicle to be operated (i.e. sedan, van, truck) is qualified to be a trainee. It is strongly recommended that trainees be in satisfactory physical condition, particularly that they meet minimal visual requirements. Students should have completed the National Safety Council's Driver Training

Course. The three parts of the EVO Course have been designed to permit maximum flexibility in scheduling; four or five 8-hr days (with a two-day range period required) are suggested.

INNOVATRIX, Inc., Ingomar, Pa.
DOT-HS-6-01336
1978; 49p 2refs
CLEARINGHOUSE TRAINING MATERIALS. SUBJECT:
Emergency Services. FORMAT: Course Guide. TYPE OF
AUDIENCE: Emergency Vehicle Drivers*. See also HS-802
564, HS-802 565 and HS-803 669.
Availability: GPO, stock no. 050-003-00330-1

HS-802 564

TRAINING PROGRAM FOR OPERATION OF EMERGENCY VEHICLES. INSTRUCTOR LESSON PLANS

The basic teaching methods required by the instructor of the Emergency Vehicle Operation (EVO) Course developed to prepare emergency vehicle (EV) drivers to operate their vehicles safely in the emergency and non-emergency mode, are provided. Based on the similarity of knowledge required for the operation of any EV, the course is divided into three parts: basic knowledge (for all EV operators), specialized knowledge (police service, ambulance/rescue service, and fire service units), and skill development (in-vehicle practice). The basic knowledge and specialized knowledge parts are divided into units, most of which are broken down into several modules providing logical places to schedule breaks, lunch hours, etc. The basic knowledge units are: introduction, some legal aspects of EV operation, selecting routes and reporting EV operations, before you drive, important physical forces and EV control, operation, and handling unusual situations. The specialized knowledge units are: operation of law enforcement vehicles, operation of ambulances, and operation of fire apparatus. Each of these units (as well as the in-vehicle practice portion) consists of the following sections, in order: description of unit page(s) containing a brief overview of the material covered, as well as time estimates for each of the modules and review exercises; trainees' knowledge objectives; and instructor preparation activities (a listing of all activities to be accomplished prior to teaching a unit). Most of the unit content pages have a two-column format. The left column contains three types of information: text materials (essentially the same as in the trainee study guide (TSG)); instructor-based text materials (information not appearing but related to information in TSG); and presentation guidelines. The right column denotes the page in the TSG the trainees should be looking at, gives cues as to when instructional aids are appropriate, and allows space for notes. A series of review questions, with answers, is presented at the end of each unit. Appended are a bibliography and masters for transparencies. The three parts of the EVO Course have been designed to permit maximum flexibility in scheduling; four or five 8-hr days (with a two-day driving range period required) are suggested.

INNOVATRIX, Inc., Ingomar, Pa.
DOT-HS-6-01336
1978; 412p 87refs
CLEARINGHOUSE TRAINING MATERIALS. SUBJECT:
Emergency Services. FORMAT: Instructor Lesson Plans.
TYPE OF AUDIENCE: Emergency Vehicle Drivers*. See
also HS-802 563, HS-802 565 and HS-803 669.
Availability: GPO, stock no. 050-003-00332-8

HS-802 565

TRAINING PROGRAM FOR OPERATION OF EMERGENCY VEHICLES. TRAINEE STUDY GUIDE

The text/workbook required by trainees in the Emergency Vehicle Operation (EVO) Course developed to prepare emergency vehicle (EV) drivers to operate their vehicles safely in the emergency and non-emergency mode, is provided. Based on the similarity of knowledge required for the operation of any EV, the course is divided into three parts: basic knowledge (for all EV operators), specialized knowledge (police service, ambulance/rescue service, and fire service units), and skill development (in-vehicle practice). The first two parts, the classroom activities, are covered in this trainee study guide (TSG), and are divided into units. The basic knowledge units are: introduction, some legal aspects of EV operation, selecting routes and reporting EV operations, before you drive, important physical forces and EV control, operation, and handling unusual situations. The specialized knowledge units are: operation of law enforcement vehicles, operation of ambulances, and operation of fire apparatus. Most of the unit content pages have a two-column format. The left column contains the text and illustrations. The right column provides space to answer the questions printed there and provides space to take additional notes on the basis of the instructor's presentation. Review exercises are provided at the end of each unit. The TSG also serves as a reference document for the trainees to use in their early weeks on the job.

INNOVATRIX, Inc., Ingomar, Pa.
DOT-HS-6-01336

1978; 240p 3refs

CLEARINGHOUSE TRAINING MATERIALS. SUBJECT: Emergency Services. FORMAT: Trainee Study Guide. TYPE OF AUDIENCE: Emergency Vehicle Drivers*. See also HS-802 563, HS-802 564 and HS-803 669.

Availability: GPO, stock no. 050-003-00331-0

HS-803 585

STATE OF RHODE ISLAND SPECIAL ADJUDICATION FOR ENFORCEMENT. VOL. 1: FINAL REPORT [TRAFFIC OFFENSES]

On 1 Jul 1975, a state law went into effect in Rhode Island which changed most traffic offenses from misdemeanors to violations and established the Administrative Adjudication Div. (AAD) to adjudicate these cases. AAD is composed of division management and four operating sections (Violation Section, Hearing Section, Driver Retraining Section, and Data System Section). During its first 24 months, AAD operated as a Special Adjudication for Enforcement (SAFE) demonstration project, and disposed of 137,316 traffic summonses, with 100,036 of these paid by mail and 37,280 adjudicated at hearings. The overall objective of administrative adjudication is to improve the processing and disposition of traffic offenses in terms of consistency of sanctions, the relationship of sanctions to the circumstances of the violation and the motorist's driving history, and the time to disposition. The two-year SAFE demonstration project is discussed in the following sections: technical summary (project objectives, background information, development of the system, summary of work accomplished, results of activities, potential applications), fiscal and personnel review, performance report by individual activity, analytic studies (reference only, to Vols. 2 and 3 of this Final Rept.), continuation plans, supplemental information (enabling legislation, rules and regulations, AAD forms and

flow, motorist surveys), index of project reports, and financial and personnel data. On 30 Jun 1977, AAD was transferred from the State Dept. of Transportation to a state-supported basis and is continuing as a permanent entity within state government.

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DOT-HS-4-00956CA

1978; 126p 9refs

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HS-803 586

STATE OF RHODE ISLAND SPECIAL ADJUDICATION FOR ENFORCEMENT. VOL. 2: EVALUATION OF DRIVER RETRAINING SCHOOLS

As a part of the administrative adjudication of traffic violations under the State of Rhode Island's Special Adjudication for Enforcement (SAFE) demonstration project from 1 Jul 1975 to 30 Jun 1977, two types of driver retraining programs were conducted for motorists who had charges sustained at hearings and were referred for retraining by the Hearing Commissioners. The decision to refer or not was made by a Hearing Commissioner based on the facts of the violation being heard and on the motorist's prior violation history. A General Education Session (GES) consisting of a single, two-hour presentation, and the Defensive Driving Course (DDC) developed by the National Safety Council, were employed as sanctioning options in the adjudication of traffic violations (in addition to, or as an alternative to a monetary fine and/or license suspension). Administration of the classes was carried out by the Driver Retraining Section of the Administrative Adjudication Div. which operated as the SAFE demonstration project during its first 24 months of operation. On 1 Jul 1975, a state law went into effect which changed most traffic offenses from misdemeanors to violations and established the AAD under the State Dept. of Transportation to adjudicate these cases. During the two years of operation, 84 sessions of the GES course were held, with a total of 3046 assigned to attend and with 2915 graduating. A total of 58 cycles of DDC were conducted, with 1827 persons assigned and 1752 graduating. Evaluation of the courses showed that both produced measurable increases in knowledge among the students. On the other hand, examination of the subsequent driving records of those assigned to the courses and a group of drivers assigned at random to untreated control groups, failed to yield any evidence that the courses were effective in reducing traffic violations and accidents. This failure to find a positive effect of the retraining schools on driving records is contrary to the general expectation from most prior studies, at least with regard to violations. It may be that the use of retraining courses as a sanction in traffic case adjudication creates different attitudes among the persons involved, than when the courses are applied as part of a subsequent driving record screening process.

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HS-803 587

HSL 79-06

Dunlap and Associates, Inc., One Parkland Drive, Darien, Conn. 06820
DOT-HS-4-00956CA
1978; 40p 15refs
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Availability: NTIS

HS-803 587

**STATE OF RHODE ISLAND SPECIAL
ADJUDICATION FOR ENFORCEMENT. VOL. 3:
ANALYSIS OF THE ADMINISTRATIVE
ADJUDICATION OF TRAFFIC OFFENSES**

On 1 Jul 1975, a state law went into effect in Rhode Island which changed most traffic offenses from misdemeanors to violations and established the Administrative Adjudication Div. (AAD) under the State Dept. of Transportation, to adjudicate these cases. AAD is composed of division management and four operating sections (Violation Section, Hearing Section, Driver Retraining Section, and Data System Section). During its first 24 months, AAD operated as a Special Adjudication for Enforcement (SAFE) demonstration project, and disposed of 137,316 traffic summonses, with 100,036 of these having been paid by mail and 37,280 adjudicated at hearings. The summonses paid by mail generated fines in the amount of \$2,069,000, while fines of \$853,578 were assessed at hearings. An analysis is presented of the administrative adjudication of traffic offenses during the SAFE demonstration period; included are evaluations of the pay-by-mail and hearing processes, a description of the data system that supports the operation, a cost analysis, and a discussion of the effects of administrative adjudication on the courts and police departments in the state. AAD has had a major impact on the court system. Removal of most traffic cases from the court's jurisdiction brought about an almost 17% reduction in the backlog of cases and has permitted the District Courts to take on several new functions. AAD also has provided savings to the police departments because the need for police prosecutors at arraignment of traffic cases has been reduced, because police spend less time at contested hearings than at contested course cases, because clerical tasks have been reduced due to the elimination of warrants in most traffic cases, and because the capias as the follow-up to defaulted cases has been eliminated. AAD is believed to have earned the confidence of the criminal justice system. Most court personnel favored the decriminalization of traffic offenses, and this step has not depressed traffic enforcement levels. AAD has become a permanent entity within the state government and is continuing with the procedures and organizational structure essentially unchanged from those developed and tested under the SAFE demonstration project.

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Conn. 06820
DOT-HS-4-00956CA
1978; 106p 2refs
Rept. for Jul 1975-Jun 1977. Vol. 1 is HS-803 585; Vol. 2 is HS-803 586. Subcontracted to Dunlap and Associates, Inc.
Availability: NTIS

HS-803 592

**PHASE 1: DEVELOPING GENERALIZED DRIVING
WHILE INTOXICATED (DWI) SCHOOL
CURRICULA. INTERIM REPORT**

As the first phase of a project to design and produce two versions of a curriculum for general DWI (driving while intoxicated) audiences, a complete review was made of selected DWI curricula over the last six years in order to identify curricula components or characteristics with high potential for adaptation to a curriculum both appealing and effective for a wide range of drinking drivers. The presence or absence of specific curricular characteristics are readily discerned in the three sets of materials that were developed in this phase: the first, a set of program descriptions which are extracts of the full curricula and highlight major components to be considered in any new design effort; the second, quick-reference matrices which facilitate information searches and comparisons among the different curricula, and can also be used in program planning, in technical assistance and evaluation deliberations, and in review and summarizing activities. Matrix I, a general review matrix, tabulates elements that qualify the merit of curricula under review; Matrix II, a comparison of informational areas to instructional techniques, summarizes data contained in detailed matrices that were prepared on each curriculum. The third product is a detailed teaching point outline which is a preliminary outline of the breadth of topics addressed in the selected curricula. It is built around the major headings of the informational content matrix and individual teaching points (i.e. single facts, concepts) extracted from existing courses. The matrices, program descriptions, and teaching point outline will be used to design curricula in the next phase. Appended are an alphabetical listing of the programs reviewed, individual matrices on informational content and instructional techniques, and a matrix of the DWI films reviewed.

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DOT-HS-7-01814
Rept. No. VS-54; 1978; 469p 137refs
Availability: NTIS

HS-803 606

**STEERING WHEEL OSCILLATIONS AND VERTICAL
MOVEMENTS IN 30 MPH BARRIER IMPACTS**

Data relating to the behavior of the steering columns of 41 automobiles (1975 through 1977 model years) when subjected to a 30-mph barrier impact were obtained from Federal Motor Vehicle Safety Standard (FMVSS) No. 204 compliance test reports in order to determine the extent of maximum deformation in the vertical plane of the steering column. Test films and associated data were analyzed to identify typical response patterns of steering assemblies. There seemed to be no typical response pattern. All vehicles tested passed FMVSS 204 (Steering Control Rearward Displacement) which specifies that the maximum horizontal rearward displacement of the steering column and shaft into the passenger compartment during a 30-mph barrier impact to be no greater than five inches; but the vertical movement was unpredictable, some columns translating upward, others downward. The steering assemblies of all the vehicles tested were found to have about one major oscillation before settling into lesser vibrations, where the motion was less than half an inch in any direction. The maximum upward and downward translations were 10.0 in and 9.5 in,

June 29, 1979

HS-803 615

respectively. The average maximum total vertical upward and downward displacements were 2.6 in and 1.6 in, respectively. The maximum vertical distance transversed during oscillations was 7.0 in. The minimum was less than 1 in, meaning that that column did not oscillate. The maximum intrusion of the steering column into the passenger compartment generally occurred during the first 120 msec of impact and averaged 4.0 in. The maximum and minimum values were 10.5 in and 1.5 in, respectively.

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1978; 127p 41refs
NHTSA Technical Rept.
Availability: NTIS

HS-803 608

THE EFFECTS OF ALCOHOL ON THE DRIVER'S DECISION-MAKING BEHAVIOR. VOL. 1: EXECUTIVE SUMMARY AND TECHNICAL REPORT. FINAL REPORT

Two coordinated experiments designed to investigate the effects of alcohol on driver decision-making, as opposed to driver control capability, are described. The first experiment consisted of a laboratory study involving a complex, interactive driver simulator. The second study was a field validation experiment employing an instrumented car and interactive test course which duplicated many of the driving simulator tasks and conditions. The purpose of the research was to determine whether alcohol affects the driver's willingness to accept risk, or whether alcohol merely deteriorates the driver's perceptual and psychomotor properties, leading to unavoidable increases in risk-taking for which there cannot be any compensation (e.g. driving slower). The results of the two experiments were quite consistent. Risk-taking increased in a dose-response relationship with blood alcohol concentration as measured by increased accidents and traffic tickets; the accident results are consistent with real-world epidemiological data. Decision-making analysis indicated that the increased risk-taking was caused by degraded perceptual and psychomotor capabilities, not increased acceptance of risk. In terms of public information and driver education countermeasures, the effects of alcohol on a driver's ability to perform complex driving tasks should be emphasized. Alcohol effects seem to increase with the complexity of driving situations, and design of both vehicles and the roadway environment should be directed toward reducing driver work load. The results suggest a new driving interlock or alarm approach. A sensitive interlock based on alcohol degraded psychomotor behavior is currently available, and the development of a test based on driver perceptual impairment is suggested. In particular, a task requiring time/distance judgments similar to those required in a signal light encounter might be appropriate, for either in-vehicle or simulation applications (the latter use perhaps in the form of a video game for self-diagnosis by drinking drivers).

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DOT-HS-4-00999
Rept. No. ST-TR-1053-1; 1978; 159p 83refs
Rept. for Jun 1974-Jan 1978.
Availability: NTIS

HS-803 612

FRONT PASSENGER ASPIRATOR AIR BAG SYSTEM FOR SMALL CARS. PHASE 2. EVALUATION. FINAL TECHNICAL REPORT

Background information is given on the development of an aspirator air bag restraint system for use in a subcompact vehicle (a stock Volvo 244) which would not present a hazard to the forward out-of-position child, and results of an evaluation of the air bag system via sled tests and a full-scale car crash test are presented. Conclusions drawn about the effectiveness of the system toward passenger injury control are based upon data which satisfy injury criteria of Federal Motor Vehicle Safety Standard 208, and also reflect subjective interpretation of results such as overall dummy kinematics (high-speed film data), consideration of load distribution (pressure) as well as force and acceleration, and an attempt to address the system in the context of real people being involved in actual automobile crashes. Tests with the aspirator air bag system produced data which satisfy injury criteria for the range of dummy sizes from a six-year-old child to a 95th percentile male up to a frontal barrier crash velocity of approximately 45 mph. Capability of the system may be somewhat lower for large occupants, but 42-mph protection has been demonstrated for the 95th percentile male size dummy. Dummy results for the same dummy size range were well within injury criteria for a severe frontal offset or nonsymmetrical frontal crash simulation on the sled at 40 mph. It appears that the system may be capable of providing protection from fatality or serious injury to front-seat passengers in a similar small-car environment up through an equivalent crash and crash mode regime. These conclusions, however, based upon results using anthropomorphic dummies, and except for the one car crash test (41.6 mph crash into a flat barrier), were obtained under the strict one-dimensional crash pulse of the accelerator sled. Occupant compartment deformation (i.e. intrusion) was not simulated, and at this high crash velocity, 45 mph, intrusion certainly could be expected. Based on the sled test results, it is clear that the aspirated air bag system would provide a much safer crash environment for a small child than if the child were unrestrained, for the child in the normal seated position. If a child were up against the system, the resultant loading on the child would be quite sensitive to the specific geometry of the vehicle interior and air bag system. However, it appears that the system can be made innocuous to the out-of-position child in the small-car environment (without degrading adult performance) by folding the bag such that during deployment, the bag would remain low. The air bag would not become fully inflated because of partial choking of the aspiration by the forward position child, thus reducing the deployment hazard. It would be worthwhile to continue developing and evaluating this aspirator air bag system.

by David J. Romeo
Calspan Corp., 4455 Genesee St., Buffalo, N.Y. 14221
DOT-HS-5-01254
Rept. No. ZP-5777-V-2; 1978; 160p 5refs
Rept. for Aug 1976-Mar 1978.
Availability: NTIS

HS-803 615

STATE LAWS ON HOMICIDE BY VEHICLE

The status of the laws of the 50 states and the District of Columbia, in effect as of 31 Dec 1977, under which "homicide-by-vehicle" probably would be prosecuted, is summarized. In

all cases, it is conceivable that vehicular homicide could be prosecuted under a state's criminal code, anywhere from its lowest degree of homicide, to first degree murder. A list of cases involving prosecutions of homicide-by-vehicle for each state is included. Thirty-four jurisdictions have laws specifically dealing with death resulting from the operation of a motor vehicle; in the remaining 18 states (Texas on both lists), unintentional homicide by vehicle generally is prosecuted under the manslaughter, negligent homicide, or reckless homicide law. It appears that homicide-by-vehicle laws have been enacted to facilitate convicting persons causing unintentional deaths through the operation of vehicles. Homicide-by-vehicle and related terms lessen the stigma attached to convictions. A jury, which would hesitate to convict a fellow road user of murder or manslaughter resulting from a simple traffic violation, may well find such a driver guilty when charged with homicide-by-vehicle. In several states having homicide-by-vehicle laws, courts have held that other laws, such as murder and manslaughter, were repealed insofar as they applied to unintentional vehicular homicides, by enactment of the homicide-by-vehicle law. Several states have separate laws with stronger penalties for persons who commit homicide-by-vehicle while under the influence of intoxicating liquor or drugs. A significant number of homicide-by-vehicle laws are unnecessarily complex and use legal jargon. A rule stating that a driver who unintentionally kills a person by violating a traffic law is guilty of homicide-by-vehicle is not only easy to understand, but it expresses the belief and rightful expectation of most highway users, i.e. safety with freedom through law. Unless a driver intended to kill a person, it probably would be impossible to obtain a conviction of homicide-by-vehicle if a traffic law had not been violated. Thus, using that standard is good common sense. It is, at least, a starting point for any discussion as to how homicide-by-vehicle laws should be adopted or improved. Each state should have a separate law on homicide-by-vehicle.

by Brenda B. Williams

National Com. on Uniform Traffic Laws and Ordinances, 1776 Massachusetts Ave., N.W., Suite 430, Washington, D.C. 20036
DOT-HS-5-01121

Publ: Traffic Laws Commentary v5 n7 (Oct 1978)
1978; 23p refs

Availability: GPO, stock no. 050-003-00333-6

HS-803 650

ENFORCEMENT FREQUENCY, SANCTIONS AND COMPLIANCE LEVEL FOR PEDESTRIAN SAFETY. FINAL REPORT [PARKING BANS]

Parked vehicles can create a visual screen such that oncoming motorists and crossing pedestrians cannot see each other, and one proposed safety countermeasure is parking bans for specific times at high-risk locations. A study was undertaken to investigate the effect of enforcement on motorist compliance with such time-phased parking bans. The time-phased, alternate-side parking regulations in New York City were utilized. Enforcement varied from no increase above normally-occurring enforcement to two additional enforcement visits per day. The results show that increased enforcement can lead to improved motorist compliance. However, the timing of the additional visits within the period of prohibited parking is critical. The observed effects developed and dissipated slowly. It would appear that enforcement strategies can be developed which produce significant compliance improvements without greatly increasing personnel costs. Time-phased parking bans

appear to be an operationally viable countermeasure approach. However, the ultimate benefit to pedestrian safety of removing on-street parking has yet to be demonstrated. If parking removal is to be examined further as a pedestrian countermeasure, short-term bans, such as the one studied, should be given specific consideration; they might be used, for example, in the areas and at times of high dart-out incidence. The in-depth examination of parking behaviors which was made during baseline data collection suggests that if a short-term ban is employed, the duration of the ban should exceed the "target" time for removal of parking. The specific recommendation is that the ban should be extended for at least one hour before and after the time of interest in order to maximize compliance during the critical period without changes in enforcement. Adjusting the timing of enforcement visits can reduce the need for extending the duration of the ban. The relationship between the type and severity of sanction on parking compliance should be investigated. Appendices cover a review of the literature and a list of references, and an annotated bibliography containing abstracts of some of the referenced items.

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Blomberg

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DOT-HS-5-01168

Rept. No. DA-ED78-2; 1978; 101p 160refs

Rept. for Jun 1975-May 1978.

Availability: NTIS

HS-803 651

COURT INTERVENTION: PRE-SENTENCE INVESTIGATION TECHNIQUES FOR DRINKING/DRIVING OFFENSES. FINAL REPORT

The development, testing, and evaluation are described of a seminar training package for pre-sentence investigation (PSI) personnel who screen persons convicted of driving while intoxicated (DWI) to determine their degree of alcohol use (i.e. social drinker, borderline drinker, or problem drinker). The activities involved in data collection, task analysis, materials development, and validation by five pilot tests (Pittsburgh, Memphis, Ames (Iowa), Boston, and Seattle) are shown. The three-part training package includes a course guide, instructor's guide, and participant's manual; the seminar is conducted over a two-day (originally three-day) period. Given the generally positive reactions from the participants and their supervisors in all test locations, it can be concluded that the project effort was successful in attaining its goal. The resulting training package will be applicable nationwide, and will fill a gap in the training currently being provided to PSI personnel. The final training package for PSI personnel has been designed to acquaint them with the history of the Alcohol Safety Action project's (ASAP) approaches to PSI, the severity of the DWI problem, the role of PSI personnel in screening, the types of tests currently used and their relative worth, a suggested "model" PSI report, and suggested rehabilitation modes for each drinker type. A participant's manual for a 12-hour judicial seminar on Alcohol and the Courts was developed additionally; its development, pilot testing in Nassau County, N.Y., and evaluation are covered. It is suggested that two companion documents (instructor's guide and course guide) be developed for the judicial seminar, that the judicial seminar materials be tried out and evaluated in two or three representative jurisdictions, with the project team guiding state or local court personnel; and that a model program of judicial and PSI

seminars be designed and developed for implementation on a statewide basis in a demonstration project, preferably where a state is just beginning to apply the ASAP concepts (e.g. New York, Pennsylvania, Iowa, Massachusetts).

by Margaret W. Nesbitt; Donald W. McGill
Applied Science Associates, Inc., Box 158, Valencia, Pa.
16059
DOT-HS-6-01515
Rept. No. ASA-493; 1978; 118p
Rept. for 30 Sep 1976-15 Jun 1978.
Availability: NTIS

HS-803 652

**MULTIDISCIPLINARY ACCIDENT INVESTIGATION.
SINGLE VEHICLE ACCIDENT STUDY. VOL. 1:
EXECUTIVE SUMMARY. FINAL REPORT**

by Charles N. Kurucz; Bertan W. Morrow; William J. Fogarty;
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DOT-HS-060-3-671
1977; 27p
Rept. for 1973-1976. For abstract, see HS-803 653 (Vol. 2,
Technical Rept.); Vol. 3, Appendices, is HS-803 654.
Availability: NTIS

HS-803 653

**MULTIDISCIPLINARY ACCIDENT INVESTIGATION.
SINGLE VEHICLE ACCIDENT STUDY. VOL. 2:
TECHNICAL REPORT. FINAL REPORT**

A study was undertaken to determine the nature and causes of single-vehicle accidents, to describe their resulting consequences, and to develop recommendations to effect a reduction in their frequency and severity. Analyses were based on in-depth investigations of 609 single-vehicle accidents in Dade County, Florida, police-reported data on all County accidents during the 13-month period for which in-depth data were collected, and a sample of four out of ten of the remaining non-single-vehicle accidents in the County. Comparisons were made of single-vehicle and non-single-vehicle accident characteristics, as well as comparisons of fatal vs. nonfatal single-vehicle accidents and alcohol vs. non-alcohol single-vehicle accidents. Factors for accident causation and injury production were identified and certain quantitative models developed. The models include consideration of the effectiveness of breakaway light standards and energy-absorbing devices, the redirection capabilities of curbs, roadway departure characteristics, and speed relationships. The analyses were used to develop and support countermeasure recommendations in the areas of education; legislation; licensing, inspection and enforcement procedures; standards promulgation; vehicle design; and highway design, construction, maintenance, and operation requirements. Specific countermeasures are limited generally to those problems which may be uniquely important in single-vehicle accidents and which have a high frequency or serious consequence. The feasibility of a given countermeasure along with the frequency and importance of a problem also is considered in these recommendations. The conclusions and countermeasures are initially classified as to whether they are directed to the reduction of accident frequency as opposed to accident severity. Within each of these two categories, they are further subdivided as being either human, vehicular, or en-

vironmental in nature. Human actions and failures constitute a major factor in single-vehicle accident causation; the most frequently identified factors include alcohol, speeding, inattention, fatigue, poor judgment, inexperience, and driver over-reaction. The contribution of vehicular factors does not appear to be as significant as human or environmental factors. Vehicle problems (blowouts, fires, etc.) precipitated 33 accidents; the most frequent vehicle factors were instability against rollover (63 cases) and inadequate tire tread depth (48 cases). The environmental causal factors are distributed widely, and demonstrate that there are problems and deficiencies in virtually every phase of highway design, construction, maintenance, and operation.

by Charles N. Kurucz; Bertan W. Morrow; William J. Fogarty;
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DOT-HS-060-3-671
1977; 138p
Rept. for 1973-1976. For summary report, see HS-803 652;
Vol. 3, Appendices, is HS-803 654.
Availability: NTIS

HS-803 654

**MULTIDISCIPLINARY ACCIDENT INVESTIGATION.
SINGLE VEHICLE ACCIDENT STUDY. VOL. 3:
APPENDICES. FINAL REPORT**

Information is presented from a study to determine the nature and causes of single-vehicle accidents, based on in-depth investigations of 609 single-vehicle accidents in Dade County, Florida, police-reported data on all County accidents during the 13-month period for which in-depth data were collected, and a sample of four out of ten of the remaining non-single-vehicle accidents in the County. Appendices contain data forms; instruction manual for coding forms; review and analysis tasks; Dade County demographic data; comparison of Dade County and national characteristics; single-vehicle accident characteristics; causal factors; selected impact-attenuating device performance, curb performance, and rollover characteristics; and motor vehicle standards involvement and evaluation.

by Charles N. Kurucz; Bertan W. Morrow; William J. Fogarty;
Anthony Janicek; James Klapper
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Environmental Design, P.O. Box 8294, Coral Gables, Fla.
DOT-HS-060-3-671
1977; 407p 8refs
Rept. for 1973-1976. Vol. 1, Executive Summary, is HS-803 652; Vol. 2, Technical Rept., is HS-803 653.
Availability: NTIS

HS-803 662

**VISIBILITY TESTS OF 1978 MODEL CARS. FINAL
REPORT**

Complete quantitative visibility data on 20 U.S.-made 1978 model automobiles are provided which can be analyzed by the National Hwy. Traffic Safety Administration for a future Notice of Proposed Rulemaking on Fields of Direct View. The models tested were General Motors Corp. (Buick Regal, Buick Skyhawk, Chevrolet Camaro, Chevrolet Caprice, Chevrolet Chevette, Chevrolet Corvette, Chevrolet Malibu); Ford Motor Co. (Ford Fairmont, Ford Fiesta, Ford LTD, Ford LTD II,

Ford Thunderbird); Chrysler Corp. (Chrysler Cordoba, Dodge Diplomat, Plymouth Arrow, Plymouth Horizon, Plymouth Volare); and American Motors Corp. (AMC Concord, AMC Gremlin, AMC Pacer). The size of "A" pillar obstruction was measured using binocular testing procedures. Monocular measurements were taken from two eye reference points in the forward 180 degrees and in the rear right quadrant of the vehicle using prescribed test procedures. In addition, scale drawings were prepared showing the windshield, the viewing area specified for the study, and the relationship of this area to the wiper area requirements as specified by Federal Motor Vehicle Safety Standard 104, Windshield Wiping and Washing Systems.

by E. Enserink
Dynamic Science, Inc., 1850 W. Pinnacle Peak Rd., Phoenix,
Ariz. 85027
DOT-HS-8-01967
Rept. No. DS-3043-78-155; 1978; 398p
Rept. for May 1978-Aug 1978.
Availability: NTIS

HS-803 666

BATTERY EXPLOSION TESTS AND LABELING. FINAL REPORT

A compilation of six task force reports on aspects of automotive battery safety, and the reports' recommendations are presented. The six objectives were to define further the incidence of battery explosion, the severity of resultant injuries, and the total societal costs associated with the explosion, using the data base available from the Consumer Product Safety Commission, and any other readily available data source; conduct tests on batteries to determine susceptibility to explosions under normal and adverse (overcharging, reverse polarity jumping, etc.) circumstances; develop an acceptance test procedure for determination of the explosion resistance of batteries; propose a standard method of battery and/or vehicle labeling of the hazards of battery explosions; propose a standard procedure for the jump-starting of vehicles; and assess the adequacy of jump-starting cable assemblies and recommend a standard. As a result of the work involved in this cooperative effort of 25 technical experts, battery explosion test procedures and pass-fail criteria have been developed which are applicable for all lead-acid automotive batteries. A standard procedure for using battery booster cables to jump-start engines has been developed; field tests proved it was satisfactory for use by persons with no technical knowledge of automobiles. A battery booster cable standard was developed. A warning label for batteries was developed, but it is not recommended for use on automotive batteries; it was found that present labeling practices are adequate to warn users of the dangers associated with batteries. Based on extremely limited data, it appears that injuries involving storage batteries occur rarely; recent, almost universal usage of warning labels, and increased usage of flame-arrester devices should achieve a marked reduction in storage battery-related accidents. It is recommended that an explosion resistance requirement be established for automotive, lead-acid batteries, measured by two tests (of the venting system to determine effectiveness in retarding the propagation of flames into the battery cells, and of the integrity of the battery current carrying path); that industry be required to meet the proposed standard for battery booster cables; that the recommended minimum instructions for using battery booster cables to jump start vehicles be shown on or near automotive batteries; that the industry be required to use a warning label on their product within one

year, but not a specific warning label; that the findings and recommendations of the report be used in educational safety programs; that all automotive batteries manufactured or used in the U.S. should be required to have acceptable flame arrester devices in the venting systems within two years; and that the proper procedure for the removal of battery vent caps be included in all applicable publications such as owner's manuals and repair manuals.

Society of Automotive Engineers, Inc., Battery Explosion Tests and Labeling Advisory Com., 400 Commonwealth Drive, Warrendale, Pa. 15096
DOT-HS-7-01662
1978; 98p
Rept. for Jul 1977-May 1978.
Availability: NTIS

HS-803 666

A SOLID STATE DIGITAL DATA RECORDER FOR MONITORING AUTOMOTIVE CRASH ENVIRONMENTS. FINAL REPORT

The overall program activities in the development and testing of a nine-channel, solid-state digital data recorder for utilization in monitoring motor vehicle dynamics during barrier and rollover crash testing are discussed. The recorder was designed to be a general-purpose, on-board data acquisition system. Each recorder channel has its own sensor preamplifier, analog-to-digital converter, 4096 x 8 bit random access memory, and digital-to-analog converter. The functions of reading and storing data by the recorder channels are determined by a single, common control module. The system was evaluated via a pneumatic shock machine, vibration testing on a shaker, 30-mph sled simulated vehicle-barrier impacts, and 30-mph vehicle-barrier impacts. The recorder was found to store and reproduce crash acceleration time histories as to shape and amplitude comparable to data obtained by a conventional hard wire data acquisition system. The triggering of the recorder store mode obtained by a preset level, or by a preset level and duration, or by an external brake wire appears to be adequate for crash testing applications. The recorder is a significant technical advancement in data acquisition associated with automotive crash environments. This on-board recording concept simplifies the existing crash test procedures considerably and shortens the preparation time for test in the laboratory and vehicle crash environment. The system in its current state of development is suitable for data acquisition in barrier impact, vehicle-vehicle, and rollover crash testing. It is recommended that the recorder channel gain and offset control be provided as an external connection to the recorder, perhaps as part of sensor connectors; that the internal trigger level select be provided as an external switch; and that vehicle crash testing be conducted so that more field experience with the recorder can be accumulated.

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DOT-HS-6-01472
Rept. No. K-78-24U(R); 1978; 73p
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Availability: NTIS

HS-803 669

TRAINING PROGRAM FOR OPERATION OF EMERGENCY VEHICLES. FINAL REPORT

The three major developmental activities involved in the preparation of a final curriculum package for use in training persons in the operation of emergency vehicles (EV's) (including emergency medical (ambulance), law enforcement, fire, and rescue vehicles) are discussed. The three-part package consists of a course guide, instructor lesson plans, and trainee study guide. The course requires five days to administer and includes both classroom and in-vehicle training. Classes can accommodate students from any one or a combination of the various emergency services. The in-vehicle exercises involve use of emergency sedans, vans, or large fire apparatus. Described are the functional analysis resulting in the description of tasks involved in the safe operation of EV's; the training analysis process used to delineate the training requirements, objectives, and course content; the pilot test and revision process, and conclusions and recommendations for improving the course. The major conclusion is that the flexibility of having one package for all services and vehicle types may not justify the added administrative burdens and the instructional compromises that were necessary to get the flexibility. It is recommended that consideration be given to repackaging the program as separate courses for each emergency service (ambulance and rescue, law enforcement, and fire service). It is further recommended that, if the National Hwy. Traffic Safety Administration (NHTSA) plans to continue with the current package, it be pilot tested and revised to ensure appropriate levels of learning; that the quality of in-text graphics be improved and that additional graphics and trainee exercises on 2 x 2 slides be provided; and that NHTSA either provide detailed specifications for an acceptable course at the start of a contract, or leave form and format decisions in curriculum and course development to the contractors. Over 300 relevant literature items are appended.

by Sanford P. Schumacher; Judith B. Schumacher
INNOVATRIX, Inc., Box 371, Ingomar, Pa. 15127
DOT-HS-6-01336
Rept. No. INNOVATRIX-1336-9-78-FR; 1978; 76p 303refs
Rept. for May 1976-Sep 1978. See also HS-802 563--HS-802 565.
Availability: NTIS

HS-803 709

PRELIMINARY FINDINGS ON THE SAFETY IMPACT OF FMVSS 121 [TRUCK AIR BRAKES]. INTERIM REPORT

Results are presented based on a preliminary analysis of the truck accident data contained in the Fatal Accident Reporting System (FARS) and Bureau of Motor Carrier Safety (BMCS) data files for the years 1976 and 1977 in a study to determine overall accident rates (accidents per hundred million vehicle miles) for trucks manufactured before and after Federal Motor Vehicle Safety Standard (FMVSS) 121, Air Brake Systems, became effective. The FARS and BMCS files contain information on over 3000 fatal accidents involving 1974 or newer air-braked trucks and over 9000 injury accidents reported by Authorized Carriers involving 1974 or newer air-braked trucks. Rates for fatal and injury accidents are computed using national exposure projections based on usage (brake system maintenance, mileage, and accidents) obtained for a random sample of 3500 trucks manufactured in 1974 and 1975 as part

of a fleet monitoring program. Exposure data, fatal accident rates, and injury accident rates are presented and discussed. The weight of the evidence at this time clearly suggests that FMVSS 121 brakes do not reduce accidents. Although a reduction in the fatal accident rate is shown for straight trucks, these accidents are only a small proportion of all fatal accidents involving air-braked trucks. While jackknifing is reduced as a percentage of all truck accidents, the frequency on a per-mile basis is not reduced. Of particular interest is the 70% to 90% increase observed for the combination units with 121 brakes on both tractor and trailer. At a minimum; the greatly increased accident rates for the completely 121-equipped combination vehicles must raise reasonable doubt as to the safety of those systems in actual use. It is held that the proportion of all accidents whose outcome can be altered by an improved braking system, and seemingly those influenced by an inferior braking system, is small. This study is able to offer no evidence that would establish the actual causal mechanism responsible for the observed increase in the accident rate. In evaluating the new brake system, the maintenance/reliability problem cannot be ignored. The frequency of maintenance increased by 35% for the 121 brake system (all major components, not just anti-lock) as compared with the pre-standard system. There is virtually no evidence of any safety benefit of FMVSS 121; in fact, the frequency of injury and fatal accidents actually may be higher for 121-equipped vehicles.

by Kenneth L. Campbell
University of Michigan, Hwy. Safety Res. Inst., Ann Arbor, Mich.
DOT-HS-6-01286
1978; 25p
Contract title: Fleet Accident Evaluation of FMVSS 121.
Availability: Corporate author

HS-803 710

HOW TO DEAL WITH MOTOR VEHICLE EMERGENCIES. REV. ED.

This booklet describes some of the most common motor vehicle emergencies and how they can be handled, with accident prevention and the safety of motorists and pedestrians being the primary concern. The discussion is intended primarily for those drivers relatively inexperienced in coping with emergency malfunctions in their vehicles. Those emergency situations requiring major repairs and the use of a tow truck or wrecker to move a disabled vehicle (e.g. blown engine, broken axle, loss of a wheel) are not included. The following topics are covered: first rule of crash avoidance (periodic checkups, as-you-start checkups), stopping on the highway, throttle sticking, brake failure, loss of steering, fires (under the hood or under the dash, in the rear of the car), loss of power-assisted braking and steering, loss of lights, overheated engines, loss of oil pressure, alternator/generator failure, windshield wiper failure, dropped driveshaft, hood pop-up, submersion of vehicle, loss of lug nuts on the wheels, exhaust system failures, flat tires and blowouts, driving through water or in heavy rain or snow, mini-emergencies (unruly children, insects, clothing and upholstery fires, fire in the ashtray), and first-aid supplies for the car (necessary items, very useful items, other useful items, and items for winter driving).

National Hwy. Traffic Safety Administration, Office of Public Affairs and Consumer Services, Washington, D.C. 20590
1978; 22p 1ref
Availability: Corporate author

HS-803 717

IMPROVED MOTORCYCLIST LICENSING AND TESTING PROJECT. DETAILED PLAN [CALIFORNIA]

This detailed plan presents administrative function, project activities, expected performance, planned schedule, and budgeted costs of the project. It is to serve as the statement of work to be undertaken in achieving the following project objectives: determine if improved testing procedures will result in a lower accident rate for novice motorcyclists, determine the efficacy and public acceptance of a more rigid motorcyclist testing program which includes a higher failure rate and is conducted on a motorcycle testing and training facility, determine if a State Motor Vehicle Dept. can administer a licensing program which includes special remedial skills training for applicants who do not pass the driving test, and determine cost effectiveness of an Improved Motorcyclist Licensing and Testing Proj. This detailed plan serves as a basis for evaluation of the project, and provides information to other agencies which may have an interest. The four and one-half year (1 Jul 1975-31 Dec 1979) \$1,539,912 project includes \$960,523 in Federal 403 funds and \$579,389 in state funds. The Motorcycle Safety Foundation has also committed \$19,000 to produce the Operator Manual, and is also furnishing motorcycles, assistance in examiner and instructor training, and other staff support. Forty-five thousand applicants from the Sacramento, Carmichael, Roseville, San Diego, Chula Vista and La Mesa field offices will be randomly assigned to one of three licensing programs; a control group (A), a group assigned to the Improved Motorcycle Licensing and Testing Proj. (IMLTP) with remedial skills training for those failing the improved skills test (B), and a group assigned to the IMLTP without the remedial skills training segment (C). The program consists of a series of countermeasures directed towards upgrading the knowledge and skills of novice motorcyclists, including a new operator handbook, an improved knowledge test, a static orientation, an improved skills tests, and remedial skills training for Group B applicants who fail the improved skills test. The relative effectiveness of programs A, B and C will be determined by following accident and conviction records. The validity of the tests will be determined by correlating driving records with test scores. Remedial skills training will be evaluated by comparing the driving records of subgroups that failed the improved skills test and received three hours remedial skills training, and those who failed but did not receive remedial training. The influence of applicant characteristics on the licensing rate and on the accident reducing effectiveness of the licensing program will be determined.

California Dept. of Motor Vehicles, P.O. Box 2411,
Sacramento, Calif. 95811
DOT-HS-5-01196

1978; 130p

See also HS-803 718.

Availability: Reference copy only

(1976), and instructional and testing materials developed for an Improved Motorcyclist Licensing and Testing Proj. being conducted by the California Dept. of Motor Vehicles are presented. The objectives of the project are to determine if improved testing procedures will result in a lower accident rate for novice motorcyclists, to determine the efficacy and public acceptance of a more rigid motorcyclist testing program which includes a higher failure rate and is conducted on a motorcycle testing and training facility, to determine if a State Motor Vehicle Dept. can administer a licensing program which includes special remedial skills training for applicants who do not pass the driving test, and to determine cost effectiveness of an Improved Motorcyclist Licensing and Testing Proj. Applicants for motorcycle operator's licenses during 1976 from the Sacramento, Carmichael, Roseville, San Diego, Chula Vista, and La Mesa field offices were randomly assigned to one of the three following licensing programs: Group A (control group), current licensing program; Group B, Improved Motorcyclist Licensing and Testing Proj. with remedial skills training for those failing the Improved Skill Test; and Group C, Improved Motorcyclist Licensing and Testing Proj. without the remedial skills training segment. The improved programs were implemented at range sites in the Sacramento and San Diego areas, and were comprised of a series of countermeasures directed toward upgrading the knowledge and skills of novice motorcyclists. The countermeasure activities include a new operator handbook, an improved knowledge test, a static orientation, an improved skills test, and remedial skills training. The on-cycle skills testing procedures, motorcycle operator manual, and knowledge test were developed by the National Public Services Res. Inst., actively supported by the Motorcycle Safety Foundation. The collection of data under a carefully controlled administrative environment was the primary responsibility of the project during 1976. The motorcycle simulator from the testing process was replaced by the static orientation. A number of pilot studies were conducted with the Improved Skill Test (.66 test-retest reliability vs. .26 of original test). A preliminary analysis of motorcycle accidents occurring during the six months from the date of implementation of the improved program showed accident means of .015, .014, and .016 for Groups A, B, and C, respectively. The six-month motorcycle accident mean of the group offered training was .021 vs. .025 for the group that was not offered training. The differences between these means were not statistically significant. Results should be considered tentative because of the small sample size and the incompleteness of some of the data.

by A. M. Osofsky; James Anderson
California Dept. of Motor Vehicles, Div. of Field Office
Operation, 2415 First Ave., Sacramento, Calif. 95818
DOT-HS-5-01196
1977; 250p 4refs
See also HS-803 717.
Availability: Reference copy only

HS-803 718

IMPROVED MOTORCYCLIST LICENSING AND TESTING PROJECT. ANNUAL REPORT 1976 [CALIFORNIA]

A technical summary providing an overview of project operations and impact (including a step-by-step history of project implementation), a comprehensive analytical study of project administration and impact for the first year of operation

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